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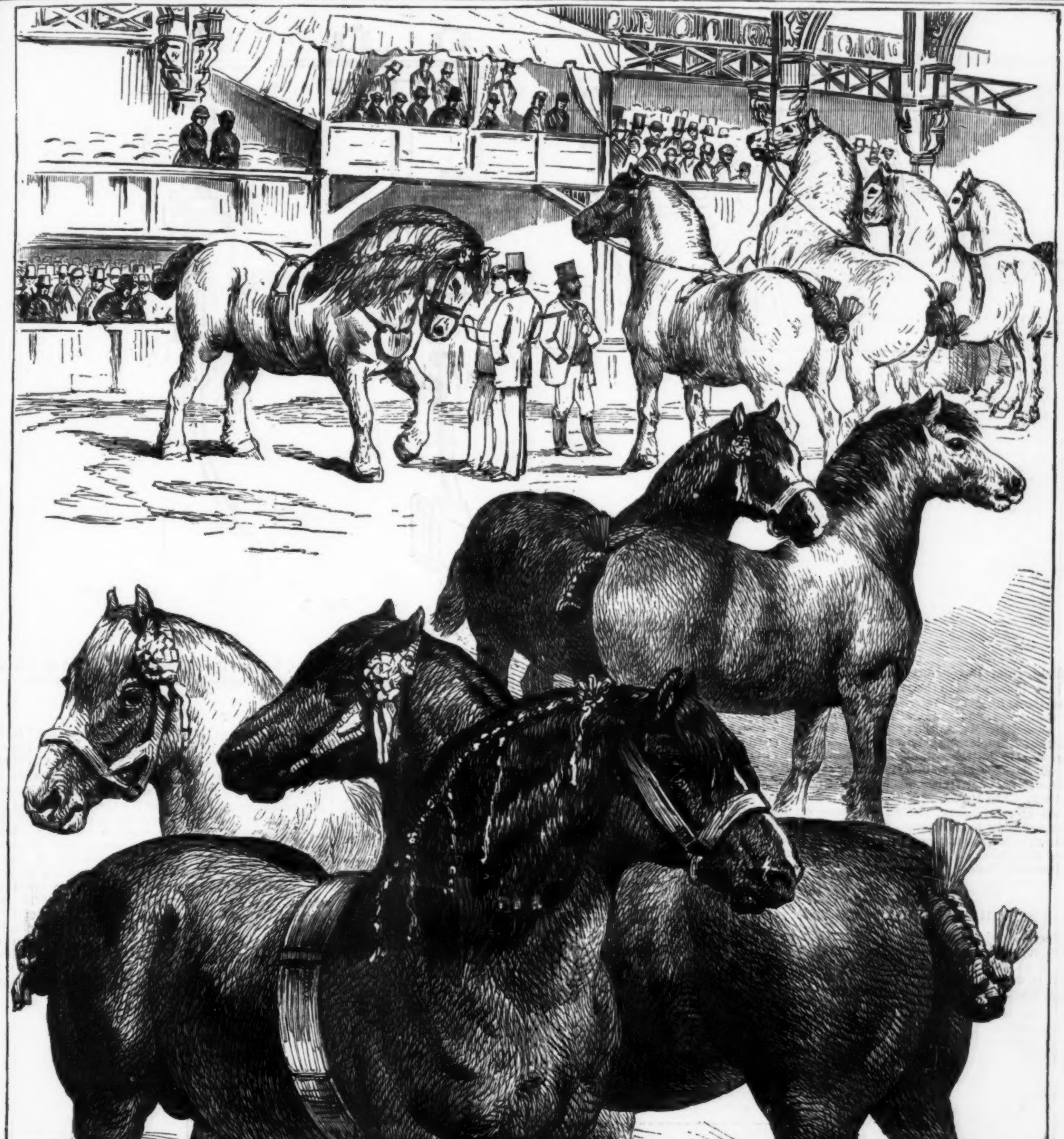


EXHIBITION OF THE ENGLISH CART HORSE SOCIETY, LONDON.

THE CART HORSE SHOW.

The second year's exhibition of the English Cart Horse Society, of which Earl Spencer is President and the Hon. Edward Coke is Vice-President, was held on March 2 at the Agricultural Hall, Islington. It was a very good show; the number of horses altogether was one hundred and forty-eight, but many of them were some of the finest of their kind. Among the contributors were the Dukes of Beaufort and Westminster, the Earls of Ellesmere, Macclesfield, and Spencer, Lord Hastings, Lord Foley, the Hon. E. Coke, Captain Machell, Mr. Walter Gilbey, and other possessors of good specimens of the most useful breeds. The horse which probably attracted most notice was Beauchief, a fine brown stallion, with white hind feet, and ten years old, which was bred by Mr. J. Sampson, at Beauchief Abbey, near Sheffield, from Devonshire Lad and a daughter of Comet. This horse, which belongs to Mr. F. Street, of Somersham Park, St. Ives, is shown in our page of illustrations, as well as a younger stallion, Westacre Wonder, bred and owned by Mr. Anthony Hamond, of Swaffham; also the Earl of Ellesmere's seven-year-old mare Black Diamond; Mr. W. H. Potter's colt stallion Coming King; and the Hon. E. Coke's black filly Chance; each of which gained prizes in his or her class, according to the limitations of age and sex. The Prince of Wales, who is patron of the English Cart Horse Society, visited the show on the first day, accompanied by the Princess of Wales and several of their children, when the horses were paraded for their Royal Highnesses' inspection, as well as for that of the judges.—*London Illustrated News.*

NEW RAILWAY CAR AXLE.

The principal object of this new car axle, invented by Mr. Miltimore, and manufactured by the Miltimore Car Axle Co., is to prevent that sliding of the wheels on the rails which is unavoidable with wheels that are fastened to their axles, when the car is passing over curves, and when there is an inequality of traction or a difference in the diameter of the wheels.

The internal steel axle, B, which is of the same diameter throughout, traverses at each extremity a casting, H, to which it is fixed by a steel bolt, I. In this way the axle has to undergo no torsional strain and is calculated to sustain the weight of the car only. It is incased in a forged iron tube, C, with cast-iron terminals, D, that form the axle-arm on which the wheels are mounted. The latter can turn freely, and are kept always at the same distance apart, internally by means of the shoulders of the casting, D, and externally by the cast-iron nut, G, which is screwed on to the extremity of the casing tube and set into the hub. At each end of the casing there is a bronze bushing, E, which revolves along with it, and forms the only point of contact between it and the axle. The frictional surface is thus situated at the lower part of the bearing, instead of at the upper part, as is usually the case. The ring, F, is clamped to the external half of the bushing, E. When in motion, the wheels, although free on the external arm, D, cause the casing tube to revolve with them because of the greater friction existing on D than on the bushing, E. On a straight road the wheels of equal circumference revolve, then, together; but in passing on a curve, the wheel on the outer rail, being obliged to run faster than its mate, will turn on the arm, D, without causing any friction on the rail.

The boxes, H, which have an oil reservoir, K, and a collector, N, are cast in a single piece. The ends of the axle enter the reservoir, K, and are kept in place by a washer and a hollow plug, O, forming a tight joint. The oil enters through the horizontal aperture, L, in the axle, and through the vertical aperture leading to the bearing, E. The lubrication is regulated by a steel rod, which plays freely in the vertical aperture. When grease is employed as a lubricant the steel rod is dispensed with. Through the threads on which the nut G, is screwed there is cut a slot, through which, by means of centrifugal force, the external axle arm may be lubricated. The oil, having served its purpose, drops into the collector, N, from whence it may be removed by a small screw-plug.

WHEEL-FLANGE LUBRICATOR.

The object of this apparatus is to lubricate the flanges of locomotive wheels when running over curves of short radius, so as to diminish the wear due to friction.

The oil reaches the rim of the wheel through a brush, which grazes the inner surface of the flange, and is kept in contact with it by a spring. The arrangement is such that there is no danger of the tread of the wheel or the rail becoming greasy and thus interfering with the adherence of the former. Moreover, the centrifugal force which causes the oil at all times to direct itself toward the greatest circumference of the wheels in motion obviates the latter inconvenience. The Society of State Railways of Austria has applied this apparatus to all its locomotives without exception, and found good economy to result from its use.

Fig. 1 shows the apparatus as mounted on a wheel. Fig. 2 shows the apparatus in section and elevation.

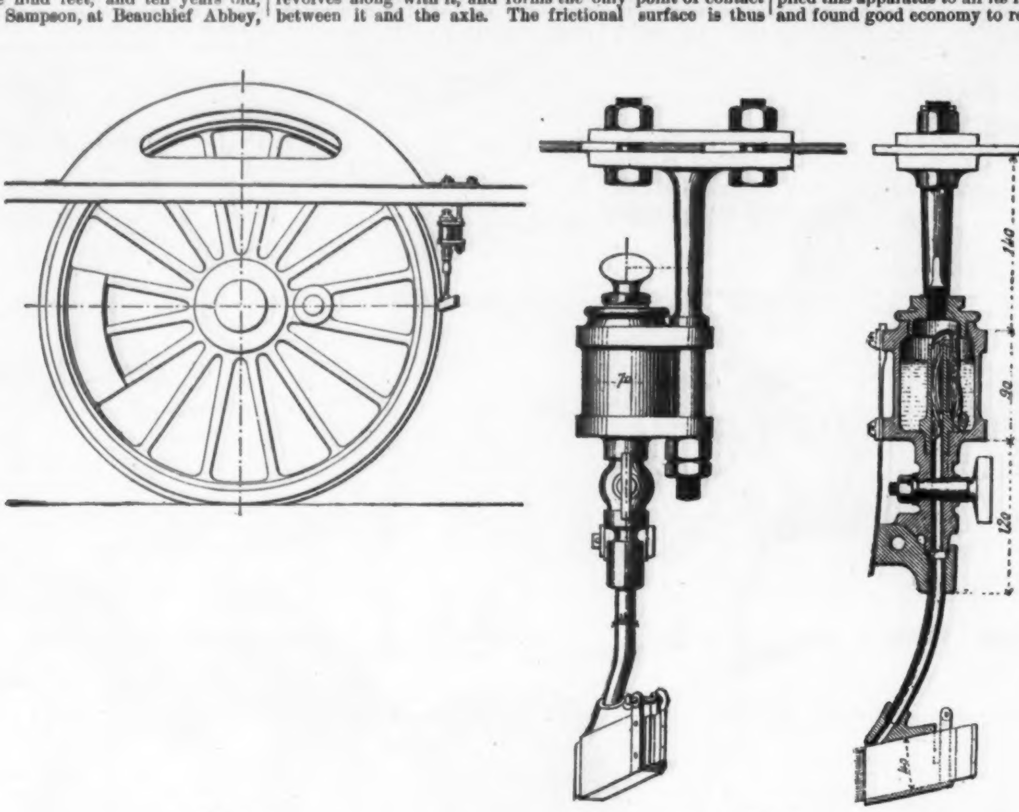
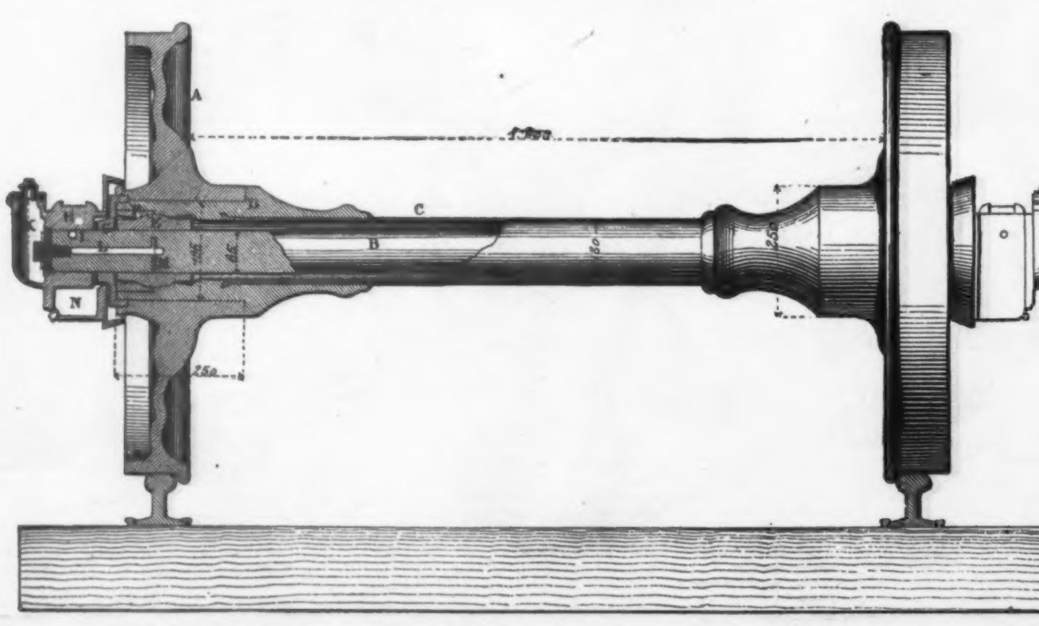


Fig. 1. Fig. 2.

WHEEL-FLANGE LUBRICATOR.

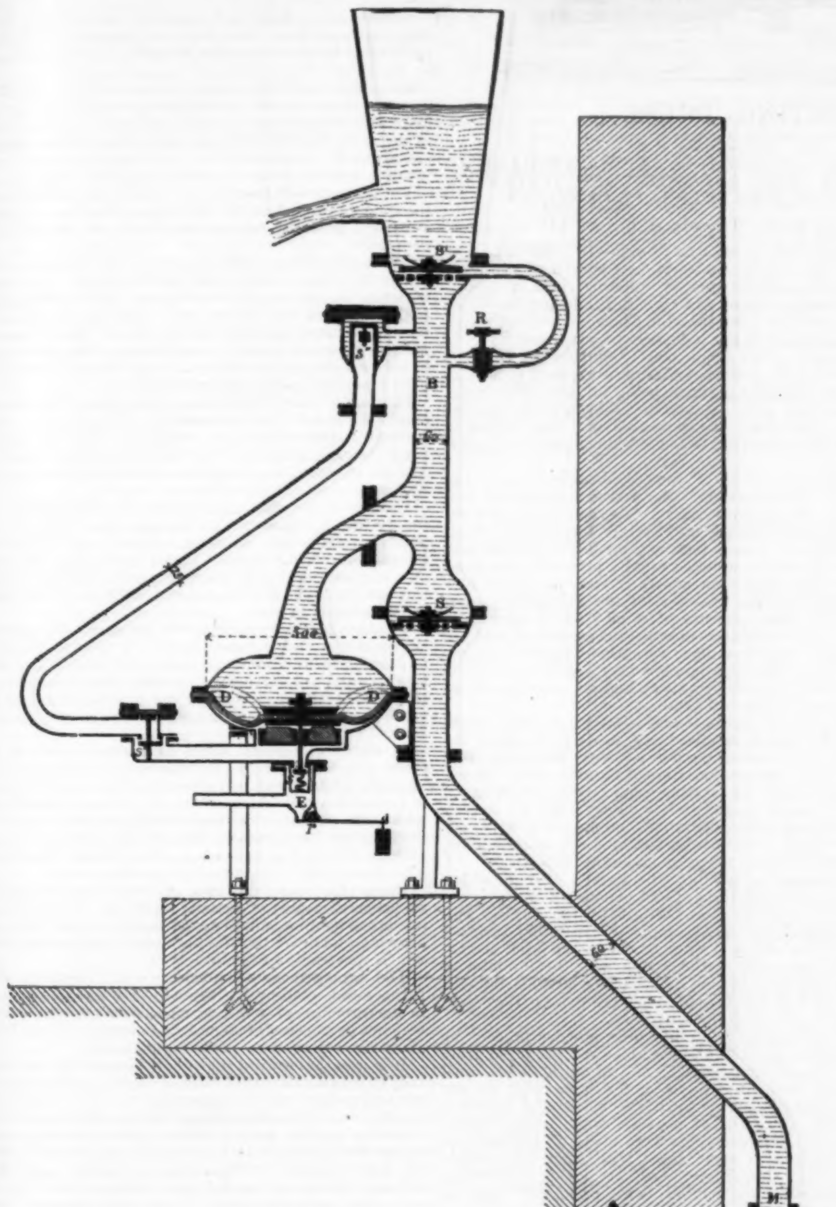
THE PULSATOR.

This apparatus is a pump which is worked by the direct action of steam, and operates by *pulsations*. The only movable parts of the machine are: A diaphragm of rubber cloth, which separates the water from the steam while in action; three small bronze clack valves for distributing the steam; and two large rubber valves for the water. The continuity of motion of these parts and the expansion are effected by the pressure of steam, combined with the effect of columns of water acting on inert bodies; that is to say, exerting at certain periods of their movements a previously acquired power, just as does the pendulum in its oscillations, the flywheel in its revolution, etc. To understand the operation of the apparatus, let us suppose that the pulsator is filled, that is, that there is water in the reservoir over the valve, S', or in the delivery pipe, and that the cock, R, has been opened momentarily in order to put the part of the machine above the valve, S', in communication with the part below it. Let us also suppose that the water which may have accumulated in the space, E, has been allowed to escape



NEW RAILWAY CAR-AXLE (Longitudinal Section and Elevation).

through the plunge-valve, *r*. Then, as soon as the steam is allowed to enter, it will find the two clack-valves, *s* and *s'*, open, and, suddenly closing the latter and raising the flexible part of the diaphragm, D, it will force the water through the valve, S'. When the flexible part of the diaphragm has been stretched until it assumes the position shown by the dotted lines in the accompanying figure, it will raise up the central disk. Then the valve, *s*, being free from the weight of the latter, and being drawn by the spring upon which it rests, will close. The steam will cease to be admitted, but the quantity introduced will expand and continue to drive the water before it until its pressure has become lower than that of the atmosphere. At this moment the clack-valve will open and give passage to the steam, and the latter will lift the clack-valve, *s''*, and thus enter the upper part of the tube, B M, where it will be condensed. The steam, leaving the space beneath the diaphragm and entering the condensing portion of the apparatus, is replaced in measure as it



BRETONNIERE'S PULSATOR. (Vertical Section.)

does so, partly by the water which occupied the upper part of the tube, B M, and partly by a certain quantity of the water that has been raised by suction. The central disk will rest again on the end of the rod of the valve, *s*, the flexible part of the diaphragm will assume its first position, and, finally, when the height of the column of water drawn up by suction into the tube, B M, is sufficient to overcome, by its action on the central disk, the pressure of the steam on the surface of the valve, *s*, the latter will suddenly open and again give rise to the series of movements that we have just described. We have stated that the cock, R, was opened momentarily only. This part of the apparatus, which serves for filling the pulsator, aids its operation so long as the air which has been able to enter the machine or suction tube while at rest, has not been expelled; but so soon as the pump has begun its regular movements it is expedient that the cock be closed.

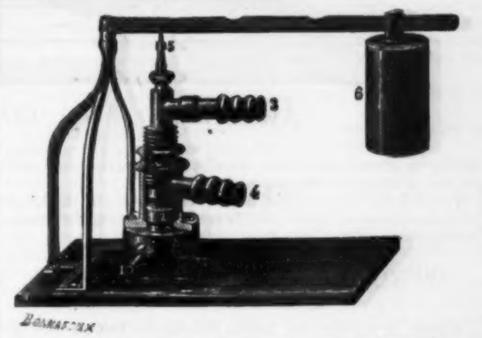
With this apparatus 50 gallons of water may be lifted 33 feet with one pound of steam. It raises the water from a maximum depth of 26 feet, and forces it as far as 80 feet. This machine is the invention of M. Bretonnière, of Philippeville, Algeria.

D'ARSONVAL'S STEAM-PRESSURE REGULATOR.*

IN certain cases it is indispensable, (1) that a given pressure of steam should be kept constant in a boiler, whatever be the outflow; (2) that fuel should be employed only proportional to the steam used; and (3) that the operation of the apparatus should be entirely automatic, while avoiding all danger of explosion. The apparatus represented in the accompanying figure solves this triple problem, and its employment is sanctioned by a daily practical test of over three years. The combustible employed for heating the boiler containing the liquid is illuminating gas; and the reservoir is a steam boiler, which may be of any form and capacity whatever. The regulator, properly so called, consists of a thin sheet of India-rubber, 8, compressed between two metallic plates, and the lower surface of which is put in contact with the steam by means of a narrow lead tube connected with the tube 1, which latter, on being filled with water, remains at the temperature of the surrounding atmosphere while still transmitting the pressure of the steam. The upper surface of the rubber is pressed by a metallic disk, 2, which through the intermedium of a stiff rod, 5, transmits to it the pressure of the weight, 6, which acts with a variable power through the intermedium of a lever. Such is the mechanism of this safety-valve. In the upper surface of the disk, 2, ends the tube, 3, which leads the gas that issues out of the tube, 4, and which from thence goes to the burner located under the boiler. Thus the rubber is loaded just as in a true safety valve. If we suppose it loaded so as to rise only at 5 atmospheres, for example, so long as the pressure is not reached the gas flows to the burner; but when the pressure attains 5 atmospheres the disk, 2, is raised by the steam and regulates the flow of the gas. After that the pressure remains invariable, whatever be the outflow of the steam. The lever is graduated in atmospheres, and a simple displacement of the weight, 6, changes the pressure in the boiler, while maintaining this new pressure constant.

This arrangement dispenses with the need of all surveillance, since if the pressure, for one cause or another, could exceed the limit assigned to it, the gas would be extinguished.

I have effected the counter-pressure by a *weight*, and not by *any sort of spring* whatever, since the ever-varying elasticity of the latter might possibly become the cause of acci-



D'ARSONVAL'S PRESSURE REGULATOR.

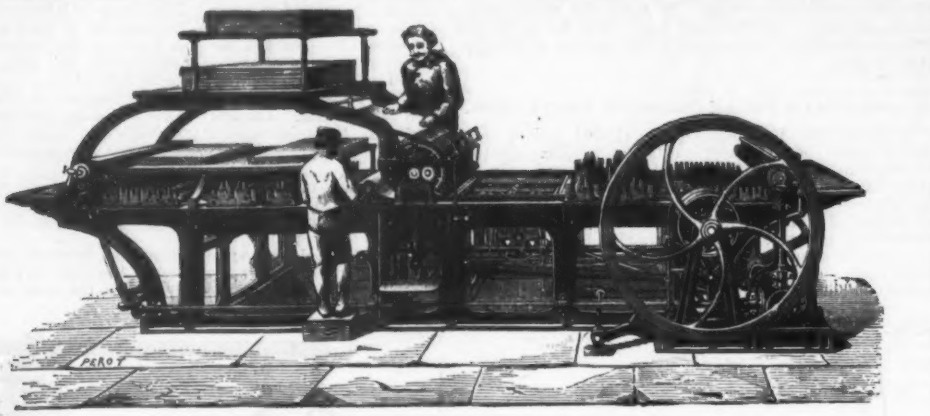
dents. It might be feared *a priori* that a weak sheet of rubber would not resist a pressure which it is possible may in some cases be considerable. But experience has shown it to be otherwise. First, the apparatus being located at a distance, the rubber remains cold; and, on another hand, the pressures that it supports, being equal on its two surfaces, annul each other without the possibility of harming it. This apparatus, which is so simple, has rendered me great service. I have been able thereby to heat a small Papin's digester in which I was causing two liquids to react at a high pressure, while doing away with all danger of explosion and all surveillance. This arrangement will be of service to more than one chemist. I shall cite, in connection, an industrial application of this regulator, which has been made in the shops of my skillful manufacturer, Mr. V. Wiesnegg.

It became a question of compressing air at a constant pressure of 100 millimeters of mercury for supplying the blowpipes of the establishment. The result was obtained by drawing in the air by a jet of steam. The mixture traverses a cooled worm where the aqueous vapor is condensed. The boiler is heated with gas, and, thanks to my regulator, the pressure therein is kept absolutely fixed, whatever be the outflow. This mode of heating, as it dispenses with a stoker, is no more costly for those minor applications than heating by coal. In fact, the fuel used is only proportional to the quantity of steam used, and we have the great advantage, in addition, of possessing an apparatus which is always ready to operate. Mr. Wiesnegg is constructing on this principle a small form of steam blower heated by gas, which has already rendered great services, owing to its portability and the perfect regularity with which it works. When a boiler has to be kept under pressure so as to be ready to operate at any moment, as is the case in steam fire-engines, the simplest means of attaining the desired result is certainly by dispensing with the trouble of surveillance and the possibility of any explosion.

* Note presented by M. D'Arsonval to the Académie des Sciences.

NEW TWO-COLOR PRINTING PRESS.

FOR many years a great problem has occupied the attention of inventors and the manufacturers of printing presses, and that is to find a means of printing a colored engraving in the text. The problem seems to have been finally solved by Mr. P. Alauzet, of France, in his new two-color printing press which is represented in the engraving on next page. *La Nature*, from which we borrow this cut, gives in one of its recent numbers a full page illustration in six colors which was printed on one of these presses along with the text, although, of course, in this instance the plate required three impressions to obtain the six colors. The press is said to be very simple. The forms containing the characters or electrotypes are placed on a table called the *press marble*, which is given a backward and forward motion as in all presses, only in this one the marble is divided into two parts, each of which receives a form for each color to be printed. The pressure is given by a *cylinder* on which is placed the paper, and which makes two revolutions on the marble during the forward movement of the latter, and thus receives the impression of two different colors. This cylinder is represented in the center of the apparatus in the accompanying figure. During the backward movement of the marble the cylinder stops completely in order to give time to remove the sheet which has just been printed, and to prepare another one destined to receive a new and double impression. The sheet of paper is registered or put properly in place on the cylinder with great ease and accuracy, so that if it needs to be registered again for the printing of a greater number of colors it will be always in the same place. This result is attained by the use of two points or needles, fixed on the registering table, and which pierce through the margin of the paper two holes into which the needles are again placed for successive impressions. The sheets fall then exactly in the same place that they occupied at the time of the first impression. The colored inks are contained in reservoirs with movable compartments, giving just the necessary quantity of ink, which is afterward distributed on the tables by means of rollers of a special composition invented by the celebrated chemist Gannal. There are two of these ink reservoirs at each end of the press, each containing a different ink. They may even serve for inking in different colors for the same form, provided the inking can be done in a direction transverse to the plate to be printed. The inking rollers are so arranged that the distribution is very uniform and that no blot or imperfection can be left on the printed sheet. They act automatically and with as much precision as could be attained by the most skillful and careful pressman. The press is likewise arranged for printing and num-



ALAUZET'S TWO COLOR PRINTING PRESS.

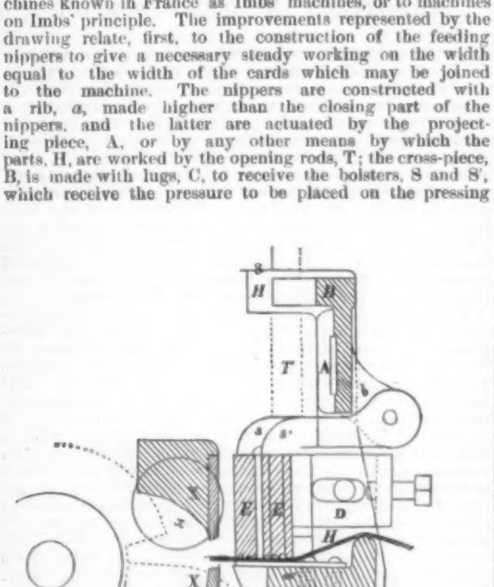
bering in colors, price lists, circulars, and other mercantile papers, at a single impression.

The Alauzet press has been adopted by some of the largest printing houses in Paris, and is said to be giving the greatest satisfaction.

IMPROVEMENTS IN COMBING MACHINES.

By M. Imbs, France.

These improvements relate principally to combing machines known in France as Imbs' machines, or to machines on Imbs' principle. The improvements represented by the drawing relate, first, to the construction of the feeding nippers to give a necessary steady working on the width equal to the width of the cards which may be joined to the machine. The nippers are constructed with a rib, *a*, made higher than the closing part of the nippers, and the latter are actuated by the projecting piece, A, or by any other means by which the parts, H, are worked by the opening rods, T; the cross-piece, B, is made with lugs, C, to receive the bolsters, S and S', which receive the pressure to be placed on the pressing



IMPROVEMENTS IN COMBING MACHINES.

pieces, E E. The parts, *a a'*, and B, are connected to the piece, H, forming a solid frame, in which are slides, D, to regulate the position of the nipper, E'. The nipper, X', works in supports, X. The fulcrum of the lever, *y*, is at the lowest point possible in the machine, and the acting part of the drawing in springs as near as possible to the nipper, X, the tappets resting on the shaft, O'; the action and counteraction being above the oscillating center. Secondly, the employment of the front cleaning brush. The spindle, K, receives a horizontal and intermittent action, so that the brush working upwards, after removing the dirt from the comb, *p*, comes in contact with the circular brush, K', which rotates as shown by the arrow, and according to the approximative tangent of the circumference. A perfect cleaning is obtained by the circular brush, K', which is worked by the brush, K. The brush, K', and doffer, K'', work in a sheet-iron casing, K'''.

Utilizing River Currents.—In parts of Germany it was usual to anchor boats in river currents, with large paddle wheels to be turned by these currents and used in grinding corn, but with this cheap power there was an inconvenience in conveying the corn to and from the boats. It is now proposed to readapt these old floating mills for the driving of dynamo-electric machines from which light or power may be transmitted to the shore.

SULPHATE OF SODA.—A NEW MECHANICAL FURNACE AND A CONTINUOUS SYSTEM OF MANUFACTURING SULPHATE OF SODA.*

By James Mactear, F.C.S., F.I.C.

The manufacture of sulphate of soda—or "salt cake," as it is termed in the alkali trade—is, as a branch of chemical industry, second only to that of sulphuric acid in importance. It is the first stage, so to speak, in the production of alkali, or "soda ash," and bleaching powder, articles which are essential in most of the industries of our country.

The process is a very simple one. Common salt is mixed with sulphuric acid, and the mixture is exposed to heat in a furnace, the resulting products being sulphate of soda and hydrochloric acid gas. In practice, however, the process has various drawbacks; the escapes of gas, more or less in amount, are very annoying to the workmen, and the labor is severe.

During the early days of the alkali manufacture, the operation of "decomposing" the salt was conducted in a small furnace of the reverberatory class, and all the acid vapors were allowed to escape into the air through the chimney. As the trade or manufacture grew in importance, and the quantity of salt decomposed rapidly increased, the damage to crops and vegetation generally, and the great nuisance occasioned by the evolution of the acid gases, caused such complaint that measures of some kind or other were adopted by all manufacturers to lessen the amount of acid gas escaping. Many ingenious plans were tried with more or less success. That of Mr. Gossage, however, rapidly proved its great superiority over all the others, and is now adopted by almost all manufacturers of alkali.

While the gaseous products were thus being dealt with, constant endeavors were also being made to improve the construction of the furnaces, but not with the same complete success as in the condensation of the acid gases. These, even so early as 1839, had become such a source of nuisance that we find a patent actually taken out by a Mr. Ford, with a view of carrying on the operations connected with the decomposition of salt "on board a flotilla at sea, at such a distance from land so that the gases may not reach shore."

It will be interesting to follow the gradual changes which have been made in the form of and manner of working the furnaces from time to time. Originally the furnace employed in Great Britain was a simple reverberatory furnace, and in it the salt and acid were mixed on the brick hearth, and the acid fumes allowed to escape with the products of combustion into the chimney. As a considerable draught could be used with this furnace, the workmen say they were rarely incommoded with the acid gases.

After the invention of the bleaching powder process by Charles Tennant, in 1799, the chlorine was produced from a mixture of salt, manganese, and sulphuric acid, until about the year 1823, when a system of decomposing the salt in furnaces, and condensing the hydrochloric acid in water, came into use. In the first instance, large iron cylinders were used, and the condensers were made of earthenware pipes, and packed, in some cases, with flints or pebbles. About this time also, furnaces with two beds or divisions were introduced, these having been previously used in France, where already, in 1816, the firm of Chaptal and D'Arcet were condensing their hydrochloric acid and utilizing it in the manufacture of gelatine from bones. Among the old papers of my firm there is an interesting series of letters from the above-named gentlemen, in which, under date of 1816, they say they were then working 44,000 lbs. per day of crude soda (black ash), of 20 per cent. to 21 per cent. alkali, and were using salt produced at Marseilles by the evaporation of the sea-water, the consumption of sulphuric acid being stated as 83 per cent. on 100 salt.

In the gradual alteration of the furnaces from the simple reverberatory with single bed, the first change was a mere alteration in form of the single bed, which was made circular in form, and dished out into a basin-like shape. This furnace was used for a number of years, and went under the name of the "Dandy furnace."

The following extract from an old paper, on the manufacture of salt-cake, is interesting:

"The muriatic acid is the alkali manufacturer's bugbear, proving an intolerable nuisance to the neighborhood, if allowed to escape into the air, and being exceedingly troublesome to condense perfectly. When salt-cake is made in such furnaces [the Dandy], the evolved muriatic acid is so intermingled with air and smoke that its complete separation is nearly if not quite impossible. The only method is by passing the mixed gases over an extensive surface of cold water; but this, if carried on sufficiently to condense the whole of the acid, would, by cooling the air, destroy the draught; in practice, therefore, it can only partially succeed. The greater part of the acid may be withdrawn, and the nuisance thus materially lessened; but some must still escape, and prove, to the neighboring farmers' annoyance, that the remedy is ineffectual."

The next stage in the development of the salt-cake furnace was its construction with two beds instead of only one, as previously used. The first, or decomposing bed, being at one time formed with a leaden pan, lined with brickwork, while the roaster bed was bottomed with brick alone. In a short time the leaden pan was replaced by one made of cast iron, built up in plates, and likewise lined with bricks, and this form of furnace was used somewhat extensively for several years. On May 8, 1837, however, Thomas Bell patented a furnace which introduced the muffle principle; the furnace, or oven, as he calls it, had only one bed, was constructed with an iron pan, protected both outside and inside by brickwork, and arched over with a double arch, so that the fire gases, after first passing through a series of flues underneath the bed or hearth, passed over the top between the two arches, so that both bottom and top were secured.

The idea was apparently quite a new one, and it was speedily improved upon by J. C. Gamble, in 1839 (March 14), who proposed the use of three divisions, ovens, or retorts, one to be used as the decomposing or mixing portion, and each of the others alternately were to receive and finish the charge from the first division when it had been stiffened up. Lee almost immediately afterward introduced a form of open furnace, in which a cast-iron pot or pan was employed, spoon-like in form.

Gamble again improved upon this form of pan, and ere long a furnace with two roasting beds, and a round shallow pan heated by the waste heat from the roasters passing over it, was in use.

From this point, invention seems to have been directed into two channels, first, toward the production of the largest amount of strong muriatic acid, leading to the development of the close or muffle furnace, and second, toward the cheapest means of producing salt-cake—leading to the development of the open roaster, or ordinary Tyne furnace.

The close roaster furnaces are those now chiefly used in the western district and in Scotland, while the open furnaces are more generally used in the Tyne and eastern district generally.

The muffle furnace now in general use varies much in its dimensions, construction, and general design; a few of these varieties are shown in the diagrams now on the wall, but within the past year or two very great improvements have been introduced into the construction of these furnaces by Messrs. Muspratt, Gamble, and Deacon, who have all aimed at so arranging the combustion of the fuel as to obtain in the flues a pressure rather than a draught.

In Gamble's most ingenious arrangement, gaseous fuel is employed, the air for its combustion being heated by passing through a nest of iron pipes placed in the flue, so that the waste heat is to some extent utilized, while a considerable amount of upward pressure is obtained in the flues of the furnace.

Deacon, on the other hand, obtains the same result with ordinary fuel, by sinking the fire-grate some depth below the floor line, and taking advantage of the power of the ascending column of fuel gases. This furnace has had considerable success, and has reduced very much indeed the leakage through the arch of the furnace, a fault all muffle furnaces are very liable to have.

So much for the close or muffle furnaces. The other class, the open roaster or furnace, has not been so much improved in its old form. The most approved form is that with an iron pan and one "roaster," the pan being heated by a separate fire, and in many cases the roaster being fired with coke, so as to avoid the choking up of the condensers with soot.

In all these various forms of furnace to which I have called your attention, the operations are conducted by means of manual labor, which is severe enough in itself, but which is rendered much more so by the amount of acid vapors which the workman has to bear with, more especially when discharging the furnaces, and which render it much more difficult to replace this class of workmen than those in almost any other department of an alkali work.

From this cause, the idea of employing mechanical arrangements instead of manual labor was one that very early presented itself to alkali manufacturers, and I have here a drawing of one of the first attempts to carry out this idea, which was tried in or before 1842.

The arrangement of machinery for operating chemical furnaces patented by Pattinson in 1848 was the first real step in the direction of reducing manual labor, and, although it was not so successful as was anticipated, it has helped to show the way to more perfect appliances.

It is true that toward the end of his specification he points out, as regards the usual form of decomposing furnace with pot and roaster, that his apparatus was only suitable for the roaster; but at the beginning of his specification he distinctly points out the application to a decomposing or salt-cake furnace with a single bed, where the salt and acid "are heated, with constant stirring, until the muriatic acid is driven off, and it has become sulphate of soda," and his claim is also clear upon this point. Little more seems to have been done until Jones and Walsh took out their patent in 1875 for a form of furnace consisting of an iron pan of a circular form, which formed the bed of the furnace, upon which the salt and acid were mixed and stirred by scrapers and plows, operated, as in Pattinson's furnace, by a central shaft.

The special feature of the patent of Jones and Walsh was a return to the old class of furnace with a single bed, and the doing away with a large amount of the manual labor. It was hoped that this furnace would have been a great success, and a considerable number were erected; but most of these have been, more or less, failures, chiefly owing to the great wear and tear of machinery, and consequent heavy cost for repairs. Whenever these furnaces have been worked at anything like their alleged capacity, the breakages have been a constant source of trouble, and only when they have been worked lightly have they been at all successful. In some few cases they have been steadily worked for considerable periods without any serious breakdowns, but in these cases there has been great care taken never to overwork them, thus keeping down the heat, and saving tear and wear.

The mechanical difficulties have, it is believed, been, to a considerable extent, overcome in the more recent furnace, patented by Jones and Walsh in March, 1880, which is constructed almost entirely on the principle of the Mactear calcining furnace, patented in May, 1876, and which is now well known and extensively adopted. But the greatest objection of all to the system adopted by Jones and Walsh—and which holds good equally with the new form of their furnace—is, that the salt and acid being all added within a comparatively small period of time, there is a great evolution of muriatic gas at the beginning of the operation, and a rapidly decreasing amount as the process continues. The following figures show the above fact very clearly:

Furnace charged with KCl.

Commenced to charge at 9:30 A.M.
" " " " 10:30 " with vitriol 150° Tw.
Vitriol all run by 1:00 P.M.
First sample, taken so soon as charge thoroughly mixed
" " at 1:30 " "

* A paper lately read before the Society of Arts, London.

Table showing decomposition each hour.

1.30 p.m.	contained	24	p.c. KCl.	=	72·70	p.c. Decompos'd.
2:30 "	"	22	" "	=	75·85	" "
3·30 "	"	14	" "	=	85·13	" "
4.30 "	"	9	" "	=	90·60	" "
5.30 "	"	4	" "	=	95·92	" "
6.30 "	"	3·6	" "	=	96·32	" "
7.30 "	"	2·4	" "	=	97·57	" "
8:30 "	"	1·2	" "	=	98·80	" "

The temperature of the gases entering the condenser, after passing through 300 feet of piping, ranged between 174° Fahr. at 10:15 A.M. to 110° Fahr. at 7 15 P.M.

Great care is necessary in working the condensers when all the acid is required to be high strength, say 30° to 31° Twaddell. The amount of water running into the condenser having to be altered many times during the progress of the charge, a wash-tower of some sort is needed, before allowing the gases to pass to the chimney.

One consideration is well worth noting there is a very considerable reduction in the amount of vitriol required for the decomposition. This, of course, applies to a greater or less extent to all mechanical furnaces, as the mixture of the salt and acid is not only more rapid, but more complete than it can ever be in hand worked furnaces. The amount of this saving is stated by various manufacturers who have tried these furnaces of Jones and Walsh to be from four per cent. to five per cent. on the vitriol used. Various other patents have been taken out for mechanical arrangements, but none of these call for much attention, except that form of furnace or apparatus invented by Cammack and Walker, which, introducing as it does a new phase of the question, is well worth careful study. To these gentlemen belongs the credit of first proposing and carrying out the continuous decomposition of salt in a muffle furnace, although the mechanical difficulties connected with their apparatus have as yet proved too much for their complete success.

The apparatus consists of a cast-iron cylinder about twenty feet in length, heated externally by a series of carefully arranged flues, and made to revolve on bearing wheels. The salt and acid are fed in at one end continuously, and forced onward by a screw and scraper arrangement, mounted on a shaft which passes through the cylinder, the passage of the materials through the cylinder being also assisted by its being laid with a slight incline (like Oxland's calciner for ores); the finished sulphate of soda is delivered at the lower end of the machine, and the hydrochloric acid gas, being not at all diluted by air or fuel gases, is very easily condensed.

Great hopes of this furnace being an entire success were entertained; but, after a considerable expenditure of money and a lengthened trial, it has been given up, the mechanical difficulties having proved too great so far.

Therefore, it will be seen, no thoroughly satisfactory furnace which will produce sulphate of soda mechanically had as yet been introduced, but the question was one which called urgently for solution. On careful consideration of all the various systems proposed from time to time, and believing that a continuous method, such as is indicated in the animal charcoal revivifying process of Norman and others, and applied to salt-cake by Cammack and Walker, was the proper direction in which to work, I abandoned a series of attempts which I had made to produce a mechanical muffle furnace, and determined to work out the problem of a continuous salt-cake furnace on the open-roaster principle.

The conditions with which a mechanical salt cake furnace must comply in order that it may be successful, are much more stringent than in the case of any of the other furnace operations of an alkali work.

In designing a furnace, the following points must be (among others) carefully considered and provided for, otherwise there is great likelihood of failure and expense.

1. Simplicity and strength of the mechanical arrangement.
2. Convenient access to all wearing parts to facilitate repairs.
3. Economy in working.
4. Freedom from escape of acid vapors.
5. Simple delivery of finished sulphate of soda without escape of acid vapors.
6. Simplicity of arrangements for regular feed of acid and salt.

The experience gained from several years' working of the "Mactear" carbonating and calcining furnace, which has been so completely successful in dealing with the question of calcining soda-ash or alkali by mechanical means, pointed at once to the suitability of its general design as a basis for the construction of a salt-cake furnace.

It required, however, a long period of time and many abortive designs and plans ere the various details were worked out, so as to give reasonable grounds for belief that all the necessary points had been attended to, and provided for, and that there was good ground for belief that the finished furnace was likely to be successful.

The furnace, patented in November, 1879, and shown in the diagrams, has been the result of my attempt to solve the problem of a mechanical salt cake furnace, and it has been successful. The general construction is very much that of the Mactear carbonating furnace, being a circular pan resting on radiating arms, which carry bearing wheels, on which the furnace revolves, the wheels running on a race or rail, and the whole being kept from working out of truth by a central pivot or bearing; the furnace is covered with an arch, carried on a curb-piece, supported on a series of pillars, and the emission of acid gases is prevented by a lute, which surrounds the iron pan.

The bed, however, of the furnace differs from the "Mactear carbonator," in that, instead of having a central opening for discharging the furnace, there is a small iron pan or pot, which first of all receives the acid and salt as they are fed in to the furnace. The flow of acid is constant, and it is regulated by a slide and equilibrium valve of simple construction. The supply of salt is intermittent, being regulated by a screw, supplied from a hopper kept filled with salt, the screw being operated by a ratchet-wheel, driven by a connecting-rod and a lever and pawl, capable of accurate adjustment as to length of stroke, gears into this wheel, so that the amount of feed given to the screw can be governed with the greatest ease.

The salt and acid being fed into the center pot, this becomes full, and the excess flows over the edge into the bed This may be either arranged in concentric rings, or, as in my later patent, be without division. As the feed continues, the materials gradually work outward, until the outer edge of the furnace is reached, when the sulphate, now completely finished, falls down through a series of ducts into an annular channel, which is closed by a cover bolted to the furnace and revolving with it, and which works in lutes so as to prevent the escape of gas; the sulphate, as it falls into this channel, is caught by scrapers, and swept around to a large box or hopper, from which it is drawn out into wagons or barrows.

The materials are mixed and turned over by stirrers, plows, or scrapers, placed, as in the Mactear carbonator, between the two flues, through which the acid vapors and products of combustion pass away to the condensers, where they are protected to a great extent from the heat.

The bed of the furnace is lined with fire-brick, boiled in tar, and set in a special cement, which becomes harder than ever when subjected to the action of the heat and sulphate, the whole bed settling into one compact mass, which resists very perfectly the action of the materials put into the furnace.

The heating of the furnace may be carried out as most convenient, either coke, coal, or gaseous fuel being used Care must be taken, however, that thorough combustion is attained, so as to prevent soot being passed on into the condensers, as it is not only wasteful in fuel, but apt to stop the condensers up.

The great advantage of a continuous plan of decomposing salt is to be found in connection with the condensation. The flow of water need not be altered for days, as, once set for a given quantity of salt and strength of acid, there is little likelihood of its requiring to be altered until some change takes place in the quantities being worked.

There is no difficulty in getting all the hydrochloric acid condensed at a strength of 28° to 30° Tw., without any wash tower, and with an escape in the chimney of much less than the Alkali Act allows. There is thus no weak acid produced, a great point gained with a furnace of the open principle, and one which places it at once on a level with the close or muffle furnaces, in which this production of strong acid alone is the great advantage The amount of condensing plant also is very much less with the new furnace, in fact, not so much as one-half what has been found necessary with the close or muffle furnaces now in use.

The salt-cake, as it is withdrawn, is almost entirely free from smell or acid vapor, and there is no trace of gas to be seen about the furnace itself while working The appearance alone of the salt cake has been found almost sufficient to enable the workmen to regulate with great nicety the feed of sulphuric acid. The results of the testing of average samples made on each shift for a week will show this:

Shift.	Tons made.	Acid (free).	Salt.
1	9·63	1·60	0·30
2	8·92	1·25	0·65
3	10·33	1·00	0·30
4	8·22	1·10	0·60
5	9·98	1·50	0·40
6	9·62	1·50	0·50
7	10·50	1·33	0·50
8	8·75	0 90	0·583
9	10·33	1·26	0·40
10	10·15	1·06	0·583
11	10·32	1·20	0·60
12	9·10	0·80	1·40
13	10 15	0·90	0·50
14	8·23	0·75	0·60
	Total 134·23	Average. 1·15	Average. 0·565

These samples were taken by lifting a shovelful from each barrow, as it was filled (3½ cwt.), and mixing, a small sample was taken from this in the usual way, every two hours, and tested. The above results are the average figures for each shift.

There is no difficulty in making, from common white salt, sulphate of 97 per cent. guaranteed, and the great difficulties which have hitherto prevented the use of ground rock salt in the ordinary furnaces, altogether disappear with this furnace, as it works rock salt perfectly, and with it turns out a greater weight of finished sulphate per shift, of a quality which need not contain, at any time, more than one-half per cent. of undecomposed salt

The quantity of work done depends, to a great extent, upon the draught In the case of the furnace now at work at St. Rollox (which is connected to a small chimney with little heat in it, so that the draught is exceedingly bad), the work done is about 135 tons per week of seven days—nearly 10 tons per shift, this with common salt, with about 7 per cent. moisture With a better draught, one ton per hour will be easily finished from common salt with this furnace, which is of 21 ft. outside diameter Deducting the area of the small pan, and of the outer ring, say 12 in. broad, there remains as a calcining bed about 231 square feet, which, finishing at the rate of one ton per hour, would give about 10 lb. per hour as the amount calcined per square foot.

The quality of the salt cake is completely under control; it can either be produced in a fine, powdery condition, suitable for glass making purposes, or it can be produced in cohering masses, which are more suitable for alkali making, as, in this form, it is less liable to be carried over into the pan or chimney by the draught

The sulphate produced is in a condition highly suited for the manufacture of alkali, as it is altogether free from the hard semi-fused lumps, such as are too often found in salt cake made in ordinary furnaces, more especially of the open roaster class. These lumps are very difficult to decompose perfectly in the ball furnace, cause the charge to take a longer time to finish and are often found as kernels of undecomposed sulphate.

In comparing the relative costs of working the new "Mactear" furnace against the old form, the question of salt-supply is an important element—whether it has to be elevated from the floor level into the hopper of the furnace, or, on the other hand, it can be brought in on the higher level, and be dropped direct into the hopper In the first case, supposing the salt has to be delivered on the floor level, as happens to be the case with the furnace at present working, then the cost of elevating will be included in the cost of the motive power of the machine.

Assuming, therefore, that in the case of both furnaces the salt is laid down on the floor at the furnace, the actual amount of labor required is, in the case of a Tyne open furnace of most modern construction, furnishing sixty eight tons of salt-cake per week of six days, three men per shift, or a little more than eleven tons per man per week. In the case of the "Mactear" decomposing furnace, one man per shift is able with ease to do all the work of the furnace, or about seventy two tons per week per man, calculated on one ton per hour. In addition for each two or three furnaces, one man is required to look after the engines and oil machinery, and at the same time look after the condensers (which require very little attention). In all, the labor may be called one and one half men per shift, or half the number required for the old furnace, while the output, being more than doubled, reduces the actual amount of labor per ton to about one-fourth what it is with the old furnace, the sulphate in each case being drawn into barrows or wagons ready for removal.

The amount of fuel so far has been about 4 cwt. of coke per ton of finished salt cake; with improved draught it is expected this will be still further reduced.

The actual saving in labor, fuel, etc., after calculating liberally for depreciation of plant and interest, will amount to about 2s. 6d. per ton of salt cake made from common salt, while to this will have to be added, in the case of rock-salt, the actual difference in cost of the salt itself.

The effect of such a reduction, when calculated out on the cost of bleaching-powder, is sufficiently striking. Assuming that fifty five cwt. of salt are required to produce the acid for one ton of bleaching powder, or equal to, say, sixty cwt. of salt-cake, the actual saving would be 7s. 6d. per ton of bleaching powder, common salt being used, with rock salt, there will be the extra cost of the salt to add to this.

The results and advantages of the new furnace may be summed up as follows

1. Greatly decreased cost of the salt cake produced—say thirty per cent. saved in manufacturing costs
2. The actual manual labor is much reduced, one-fourth the number of furnace men being sufficient, while, as they have not to contend with the escapes of hydrochloric acid gas which are met with in the old furnaces, a class of work men can be employed much more easily dealt with than the ordinary decomposer, who is rather apt to give trouble, and is not easily replaced
3. The feed of salt and acid being continuous, so is the flow of acid vapor to the condenser, the supply of water can, therefore, be constant, and does not require much attention. The amount of condensing space required is very much less than with the old furnace (about one half or less), and the acid can all be made of 30° Twaddell if required, without the use of a wash-tower
4. The quality of the salt cake is more uniform than that produced by the old furnaces, and is completely under control
5. Rock salt is worked quite as easily as common salt in this furnace; none of the difficulties which are found in the attempts to use rock salt in the ordinary furnace, or the danger of breaking the pots, are met with, and the salt cake is quite as well decomposed besides, as the rock salt is free from the moisture present in the common salt, a larger output of salt is obtained
6. Much less ground is required for the erection of these furnaces, and less roof space is, of course, necessary, while the whole is easily controlled by the foreman, whose duties are much more readily performed than where he has to superintend a series of small batches.
7. Should it be considered desirable, a mechanical draught can be used, and complete condensation effected.

A group of, say, six of such furnaces, each capable of turning out some 150 tons per week of salt cake, fed from a high level salt-store by means of such simple mechanical means as the traveling belt, used in grain stores, which shall deliver the salt into the service hoppers, the finished salt-cake being discharged into wagons, which shall be run direct to charge the revolving black ash furnaces, is what I hope ere long to see at work.

These would be worked at a very low cost; and if driven from either one or two main engines, could be worked with one foreman, one engineman, and eight workmen at most per shift; and, in addition to the economy in cost, the great advantage of a works absolutely free from the irritating fumes of hydrochloric acid common to the present style of furnace would be obtained.

I am now preparing plans for such an arrangement, and trust ere long to see my ideas carried out.

PROFESSOR TENNANT, F.G S.

By the death of James Tennant, on the 24th of February last, at the age of seventy three years, the Society of Arts loses an old and active member. Mr. Tennant was the assistant, and afterward the successor of J. Mawe, author of "Travels in Brazil" and of a "Treatise on Diamonds," whose original series of minerals found a nucleus for the large collection of metalliferous minerals, geological specimens, and fossil remains which Mr. Tennant eventually gathered together Mr Tennant also possessed a rich collection of precious stones, of which the Devonshire collection formed an important part. He was, for many years, Professor of Geology and Mineralogy at King's College, London, and after resigning the Professorship of Geology he retained the post of Professor of Mineralogy, which he held at the time of his death. In conjunction with the late Professor Ansted and the Rev W. O. Mitchell, he wrote, in 1857, the "Treatise on Geology, Mineralogy, and Crystallography" for "Orr's Circle of the Sciences." He was also the author of descriptive catalogues of fossils, and of popular lectures on the sciences in which he was specially interested. Mr Tennant was an energetic member of the Turners' Company, and took special interest in the action of that company for extending technical education. He was elected a member of the Society of Arts in 1846, was a constant attendant at the meetings, and frequently joined in the discussions, besides reading a paper on "South African Diamonds," on November 23, 1870.

Rusty-colored spots were noticed on some hammock canvas used by the French army in Algeria Dr. Tripier reported that when the canvas was washed dark spots appeared, and the material soon fell to pieces M. Balland made this matter the subject of a paper read on Feb. 28 before the French Academy of Sciences, and said that the spots were probably due to iron sulphide, produced by alkaline sulphides in the artificial soda, and by iron oxide fixed by the stuff in manufacture The sulphide passed into the state of sulphate under atmospheric influences by a combustion which caused a destruction of the canvas.

An invention has recently been patented to prevent the explosion of steam boilers by placing a partition across the boiler slightly above the water line, providing an opening through this partition, which is adjustable, and through which the flow of steam can be regulated to be equal to the average intermittent flow required for the engine. It is claimed that this prevents dangerous variations of pressure on the surface of the water, hence preventing explosions. It is an American invention.

SUGGESTIONS IN DECORATIVE ART.—EMBLEMS IN CAST IRON, DESIGNED BY C. BECK, STUTTGART.

THE MICROSCOPICAL ANALYSIS OF WATER.

CHEMICAL analysis is powerless to reach those delicate particles which constitute organic germs. There exists no method of getting at the actual weight of these impurities, and it is impossible for the chemist to say what is the proportion of these miasms that may do injury to the health. Very foul water may sometimes be drunk for a long while without causing any apparent harm, and all at once accidents may supervene which may demand attention. The malady which attacks those who make use of such water, while it spares the neighbors employing water from another source, is a contagious one. An inquest being opened, demonstrates either that the dejections of a person affected with an infectious disease have infiltered into the water, or else that the source, already impure, has undergone an alteration of temperature sufficient to bring about rapid putrefaction. There are few physicians who have not had to authenticate cases of this nature. The sixth report of the London Commission on Insalubrious Waters, and the statistical report of July 20, 1879, offer numerous examples of them. Facts demonstrate that it is not the organic matter of itself that renders water unhealthy, but it is the organized bodies or germs which have entered the liquid or which have developed very abundantly therein under favorable conditions.

Prof. Frankland has established it as a rule that we may admit, that all water containing 1·5 of organic nitrogen in 20,000 is a really dangerous one, and that the smaller the quantity of nitrogen in proportion to the organic carbon, the less chance there is of meeting animal or vegetable impurities. It must be remarked, however, that it is impossible to mark out a very precise limit in so delicate a question. The data upon which an analysis of water rests will serve, then, only as aids in forming a judgment, which will be modified by circumstances, as to the source, the hour, the locality from which the water has been taken, etc. It may turn out that it has been collected precisely over the point where the infectious matters are entering the river and changing the character of its waters.

The germs of specific diseases have hitherto escaped the ablest chemical analysis. Waters which are apparently clear and limpid may contain in solution or in suspension minute quantities of organic matters and become turbid on the application of heat. Matters that are most quickly oxidizable are the most dangerous ones. No known process of filtration will render infected water inoffensive or sufficiently pure to serve for potable use. The most palpable forms of impurities which are met with in river waters escape the observation of the chemist because the reagents employed by him destroy these embryonic forms of animal and vegetable life. For these various reasons, the most efficacious examination is a physical analysis, and the microscope becomes a valuable aid to the test tube.

When we wish to submit water to a microscopic examination, it is necessary to take a sufficiently large bottle of the liquid to be tested, and to expose it for a day or two to a moderate heat in a well-lighted room, when there will form a deposit covering the bottom of the vessel. This deposit is carefully removed by the aid of a pipette or glass tube, long enough to reach the bottom of the vessel without producing too much agitation. Then this sediment is placed on a glass slide for examination under a 0·2 inch objective. If the water has been rendered foul by organic infiltrations, there will be observed therein a great number of minute corpuscles—epithelium, muscular fibers, starch granules, hairs, ligneous fibers, fungi, confervæ, diatoms, and, occasionally, infusoria (like the *Paramæcium*) or entomostraca. The existence of these different kinds of infusoria in water does not always indicate extreme danger, but the abundance of them generally proves, especially in summer, that there is a certain amount of organic impurities in the liquid of a suspicious nature. In reality, unless these beings find sufficient nourishment they promptly die, and their accumulated *débris* furnish a new quantity of putrescible matter which remains in suspension and easily passes through all filters. The annexed engraving represents the organisms observed with the microscope in the sediment deposited by the water supplied to London at the southern part of the Thames. We may count therein no less than nineteen different genera.

ORGANISMS CONTAINED IN THE SEDIMENT OF LONDON WATER (× 800).

1. *Daphnia pulex*. 2. *Chilodon*. 3. *Paramæcium*. 4. *Acineria incurvata*. 5. *Paranema globulosa*. 6. *Cercomonas*. 7. Group of *Actinophrys sol*. 8. *Amaba*. 9. *Amaba diffluens*. 10. *Protococcus pluvialis*. 11. Various diatoms. 12. Desmids. 13. Confervæ. 14. Spores of fungi. 15. Fragments of vegetable tissue. 16. *Amaba* further enlarged. 17. *Cyclops quadricornis*. 18. *Cypris*. 19. *Anguillula fluviatilis*, etc.

The most practical means of arriving at the real state of the question—the importance of these organisms from a sanitary standpoint, and their probable effect on human beings when they are introduced into the economy—is to enumerate the different diseases to which they give rise.

1. Diseases of the digestive apparatus: Dyspepsia, diarrhea, cholerine, and dysentery, to which should be added entozoa or internal parasites—tenias, ascarides, filarias, and diatoms. The latter are especially harmful to sheep.

2. Specific diseases: Malarial fevers, typhoid or putrid fever, cholera, yellow fever, and relapsing fever.

3. Diseases of the skin and subcutaneous tissues: Furunculus, Delhi boil, Damascus boil, Aleppo button, fungous tumors; and, in certain localities, goiter, calculus, and osteocolla.

It may thus be seen at a glance that the microscope bears a strong accusation against contaminated waters; it allows us to make one advance more in the analysis of these liquids, and shows us that the danger, from a sanitary standpoint, cannot be too highly estimated. Very recently, for example, investigations have brought to light a new source of enteritis, which may be attributed to the presence of nematoid worms introduced into the organism by drinking water, just as we see the dangerous diatoms introduced into our domestic animals. The relation of bacteria to typhoid fever is generally admitted. We possess no magnifying power sufficient to show the structure of these microscopic vegetable forms, yet it is easy to demonstrate their presence, on account of their prodigious power of reproduction. They live in colonies, and owing to a sort of gelatinous envelope they are difficult of destruction—their union makes their strength.

Those of my confreres, says Mr. Jabez Hogg (from an article by whom we glean the foregoing particulars), who have studied the question with care, admit that the bacteria exhibit to us in a visible form the contagion of putrid fever; and to cite the words of Mr. Simon, it is difficult to conceive, in the production of diseases in a civilized society, of a picture more painful than the one we have in question. Of all diseases that can be ascribed to filth this is truly the type and quintessence; sometimes propagating itself by a hidden advance, but often in the most open manner, it can invariably be traced back to one source, *filth*. This infectious disease pursues its course from one human being to another by inoculation, and the material instruments of the latter are the germs of fecal matters, which man's filth and want of foresight allow to become mingled with the waters which serve him as a beverage.

ROTATING STAGE FOR THE MICROSCOPE.

AT the last meeting of the Royal Microscopical Society a new mechanical stage for the microscope was exhibited by Mr. J. Mayall, Jr.

We understand that the stage was designed by Mr. J. M. Moss, of Messrs. Watson & Sons, 313 High Holborn, as part of a new microscope stand, which is now in process of manufacture; but as it can be applied to any stand whatever, and presents several points of novelty, we here give a figure of it.

The new stage is of extreme thinness, all the motions, vertical, horizontal, and diagonal, together with the power of a complete rotation, are obtained in a total thickness of under a quarter of an inch.

The construction of the new stage will be readily understood from the figure.

The lower plate or bar traveling vertically, which is sunk below the surface of the stage, moves in a dovetailed groove plowed out of the rotating plate, and carries a pinion, whose teeth gear into a rack cut into or attached to one side of this groove. By turning the milled head fixed to this pinion—the upper one in the figure—the plate carrying it moves in a vertical direction. To this bar is attached another at right angles, with a similar groove plowed out, in which works a second plate, having teeth cut upon its lower edge gearing into those of a second (hollow) pinion placed on the first, and, by means of a tube fitting the axis of the latter, turning independently upon it by the lower milled head shown in the figure. Thus, as with the ordinary "Tyrrell" pinion movement, by turning either of the milled heads separately, the rectangular motions—or, by turning them both together, diagonal motion—can be obtained.

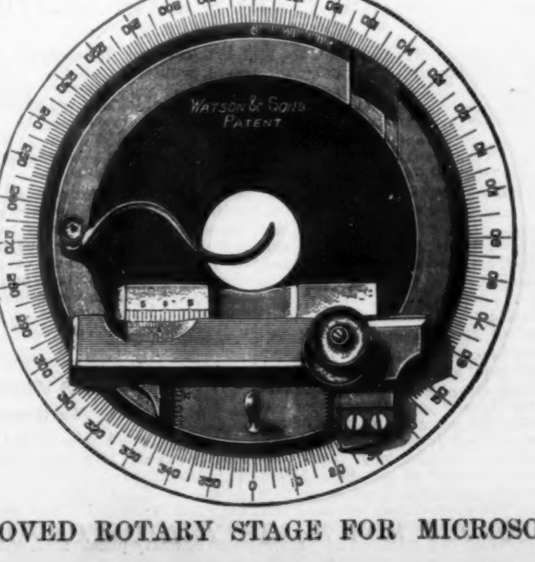
To the plate or bar, traversing horizontally, is attached the top plate (upon which the object slide is placed), the thickness of which is about the fiftieth of an inch, and as this plate works dead upon the surface of the foundation plate of the stage, this extreme thinness in no way affects the steadiness or rigidity.

It will be known to many readers that in a stage recently made by Tolles, of Boston, U.S.A., the milled heads are placed as in this, standing vertically to, and within the circumference of the stage; but by placing them as here shown both upon the same axis, the entire control of the movements of the object is conveniently effected by one hand.

The top plate has an improved spring arrangement (largely adopted in America), for securing the slide; upon unscrewing the milled head on the left hand, the spring may either be turned aside or removed altogether, when the stage will be free to carry a trough or any other large object.

The usual graduated "finders" are added, but instead of the ordinary pointers, verniers, reading to one one-hundredth of an inch, are applied.

The circular stage rotates within a broad, fixed ring. This ring, which is preferably made of phosphor-bronze, is graduated round the whole circle, and the reading is taken by a vernier. For petrological or other purposes, requiring exact angular measurements, the vernier will be found of service. In the stage figured the range of the rectangular motions has been limited to an inch in either direction, but when requisite this can be largely increased.—*Eng. Mechanic.*



IMPROVED ROTARY STAGE FOR MICROSCOPE.

THE RADIOGRAPH.

MR. D. WINSTANLEY, F.R.A.S., of Richmond, has for some time past sought to improve on existing instruments for measuring the duration of sunshine, and he has now produced the apparatus illustrated by the accompanying engravings. It has been tested in the Isle of Man with, we understand, great success. Its construction is very simple, and will be readily understood. Fig. 1 is the apparatus for measuring the duration of the sunshine. Fig. 2 shows the radiograph, an instrument which records both the duration and the intensity of sunshine. Fig. 3 is a facsimile of the record made by the instrument shown in Fig. 1, while Fig. 4 is a facsimile of the record made by the radiograph. In Fig. 1 a delicate balance carries two bulbs, T T'. The left bulb, T, is alone exposed to the possible radiation of the sun. The balls, A and B, are fitted on screws, and are for the adjustment of the balance of the beam. The adjustment is so made that in the absence of sunshine the beam rests gently on the support at E. When the sun comes on to shine the air in the left-hand bulb becomes dilated and forces the mercury to the right hand of the tube, thereby bringing a considerable portion of its weight to bear upon the pencil point, which draws a line upon the paper disk supported on a brass disk driven by a clock. When the sun ceases to shine the opposite of this takes place, the air cools, the mercury returns, the beam assumes its original equilibrium, the pencil point is raised, and the production of the trace stops. The radiograph consists substantially of two bulbs of glass, A B, connected by a tube which is circularly curved and mounted concentrically upon a wheel of brass which turns through its geometric center on a knife edge of hardened steel resting on agate planes. Half the bend in the connecting tube is filled with mercury. Both bulbs are closed, and one is painted black. The temperature of the air obviously has no influence on an arrangement of the kind, for its effects are experienced in both bulbs the same, nor is it influenced by the barometric variations of the outer air. But under the influence of radiant heat the air contained in the blackened bulb expands, compressing that within its fellow, and by pressure on the mercurial column which the tube contains, swings the wheel into an angular position of equilibrium, which varies with the intensity of the radiance to which it is exposed. Accordingly, in so far as now described, the apparatus is a "radiometer" in the proper meaning of the term, *i. e.*, a measurer of the thermal radiance to which it is exposed. A needle, prolonged from one of the radii of the wheel, is brought in gentle contact with a metallic cylinder driven by clockwork at an even speed, and the radiograph is complete. A piece of glazed paper is wrapped around the cylinder already named, the ends are secured, and the surface carefully and evenly smoked quite black. The needle of the radiograph rests gently on the surface of a cylinder covered in this way. Every passing cloud which floats before the sun makes the needle rise and fall, and at each rise and fall it leaves a clear thin line. The brighter the sun the higher will be the line, the heavier the cloud the lower it falls, while the constant rotation of the cylinder separates the effect of the different clouds, and produces a diagram on which we see at a glance the variations in the solar radiance for every moment of the day. These diagrams are fixed by immersion in a bath of weak lac varnish. When this is dry the black previously so easily removed is proof against friction, and as firmly fixed upon the paper as is the ink with which we print. The "radiograms," as Mr. Winstanley calls these diagrams of solar radiance, are very curious things, and have already shown some facts of which we should imagine few people have even dreamed. The radiance of the sun is almost always shown, for minutes at any rate, and often enough for hours before his time to rise, and, very singularly, the maximum of nocturnal radiance is attained at the noon of night. As the sun approaches the meridian of our antipodes the needle of the radiograph rises slightly from the datum line, and like a sleeper who goes over again in dreams the proceedings of the day, it writes down feebly "there is solar radiance" at a time when above all others one would fancy there was none. But for the frequency of its occurrence, and the very even distribution of curve at the anti-meridian passage of the sun, one would be inclined to attribute the observed effect to the radiation from the earth. In several of the radiograms the passage before the sun of several hundred clouds is shown in a single day, and in some instances as many as three in a single minute's time. The radiograph when used is inclosed in a box of copper, the bulbs projecting upward into a dome of glass. The whole has hitherto been fixed on a wooden stand, the legs of which are firmly embedded in the ground. In this condition, according to the *Manx Sun*, it weathered out, on the lawn of Government House, Isle of Man, the heavy gales which blew between the 17th and 24th of April, 1880.—*The Engineer*.

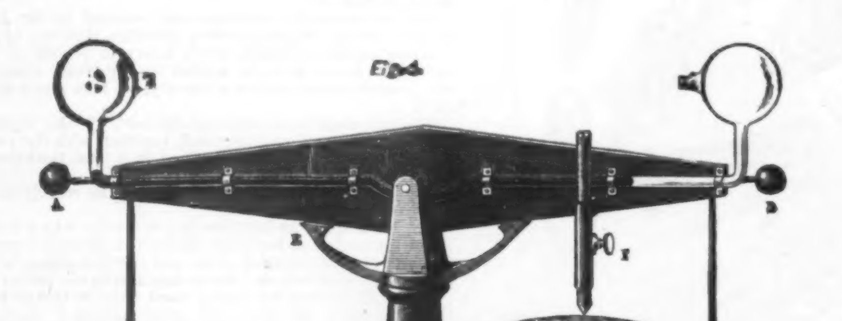


Fig. 1.

Fig. 2.

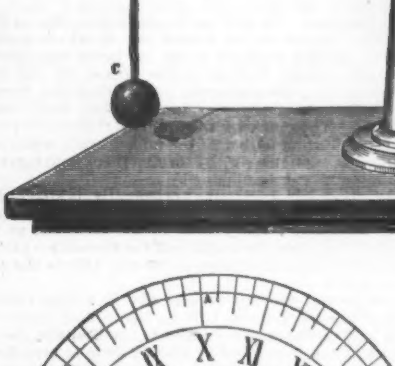


Fig. 3.

Fig. 4.

WINSTANLEY'S RADIOGRAPH, OR SUNSHINE RECORDER.

DISTRIBUTION OF LIGHT IN THE SOLAR SPECTRUM—SPECTRUM OF THE COLOR-BLIND.

By J. MACE and W. NICATI.

IN three of the cases of color-blindness examined the perception of the red is exceedingly enfeebled. In the yellow their sight is almost normal, and in the green their perception is even better than that of the normal eye. In the fourth case, on the contrary, the perception of the red is more acute than in the normal eye; the yellow is distinguished fairly, while the perception of the green is weakened. The blue and green are seen normally. Among the color-blind of the same class (not perceiving the red ray) there exist decided differences in the perception of the blue and the violet. The author's experiments prove the existence of two distinct species of color-blindness, and they overturn the theory of colors of Hering. According to this writer two photochemic substances are concerned in vision, the one in the perception of red and green, and the other in that of blue and yellow, one member of each group acting by disassimilation and the other by assimilation. The facts observed agree with the Young-Helmholtz theory of colors. We may imagine in the retina three distinct photochemical substances, corresponding to the three fundamental colors, red, green, and violet.

OILS FROM SCHISTS.

By GASTON BONG.

THE solid residues serve for the manufacture of alum, and may become an important source of lithia. The acid tarry matters contain sulphates of the bases of the pyridic series, especially of corindine, rubidine, and viridine. Aniline is not sensibly present. The insoluble portions and the alkaline tars contain peculiar phenols, thymols β and γ. There is no ordinary phenic acid, and very little thymol α.

[AMERICAN CHEMICAL JOURNAL.]

BRIEF REVIEW OF THE MOST IMPORTANT CHANGES IN THE INDUSTRIAL APPLICATIONS OF CHEMISTRY WITHIN THE LAST FEW YEARS.

MATERIALS AND PROCESSES CONNECTED WITH THE CONSTRUCTION OF BUILDINGS.

CHIEF BUILDING MATERIALS FOR EXTERNAL USE: STONE AND BRICK.

PROGRESS has been made in the manufacture of artificial stone, both as to the character of the material turned out and the scale upon which it is used. The first practically successful method of production was that of the original Ransome patent, but it involved heavy consumption of fuel in baking the blocks moulded from sand and solution of sodium silicate, with more or less defacement of the surface of the blocks by smoke. It has been generally replaced by the use of hardening solutions, chiefly that of calcium chloride, applied at ordinary temperature to the mass of silicious sand and soluble glass. One of the most interesting and valuable improvements is that by which the so-called "Victoria stone" is made. Blocks of concrete are moulded from hydraulic cement of good quality, and when dry these are immersed in a solution of sodium silicate, in which has been placed a quantity of silica in easily soluble form, usually of infusorial origin. This calcareous concrete is gradually hardened by the formation of calcium silicate, while the alkali liberated from the solution attacks and dissolves fresh portions of silica, a very limited quantity of soda thus becoming the carrier for a large amount of silica transferred to the hardening block. The process is economical, and diminishes the tendency to unsightly efflorescence of alkaline salts on the surface of the stone when used. The principle of forming by precipitation from successively applied solutions an insoluble silicate or aluminate with which to close the pores of natural stone, and so reduce the effect of weathering, has of late years been employed with moderate success in preserving the walls of public buildings; but, although the principle itself is sound, the difficulty of really penetrating the stone to any considerable depth with the solutions has tended to limit materially the practical value of the process. The manufacture of enormous blocks of concrete, sometimes of 250 or 300 tons in weight, to be lifted bodily from the place of their production and by means of floating derricks lowered to their positions in the foundation of subaqueous works, is a comparatively novel application of artificial stone, but involves questions of engineering management only, there being nothing new in the chemical aspect of the production of the blocks themselves. To a small extent iron furnace slag, cast into rectangular blocks as it flows from the furnace, has been brought into use as a building material instead of stone.

Probably the most notable change in the practice of brickmaking has consisted in the wide-spread substitution of dry moulding under heavy pressure for the ancient method of moulding the clay with water enough to form a soft dough. The great saving of time arising from the bricks as moulded being at once ready for the kiln, coupled with the saving of space required for drying, reduction of labor in handling the bricks upon the drying yard, and avoidance of the risk of injury by rain on open yards or expense of sheds to guard against this, constitute very material advantages.

favor of the more modern practice. Iron furnace slag, whose use in the form of cast blocks has been noted above, has also been sparingly applied, after crushing, to the manufacture of bricks. Great advances have been made in the production of ornamental tiles and the superior kinds of terra cotta for architectural use, but the improvement has been chiefly on the artistic side of the manufacture in form and coloring rather than in the purely technological direction. Although not strictly belonging to this division of the subject, it may be noted that in fireproof brick for furnace linings and the like applications, improvement has resulted from the substitution for mixed materials as found in nature, often uncertain and variable in composition, of nearly pure silica (crushed quartz), of alumina in the form of bauxite, and of lime and magnesia in the Thomas and Gilchrist linings for Bessemer converters; these materials being in each case mixed with so much only of foreign matter of opposite chemical character (basic and acid respectively) as shall insure compactness without fusion in burning.

LIME BURNING, MORTAR AND HYDRAULIC CEMENTS.

One of the chief modifications of practice in burning lime has been the invention of General Scott, R. E., for producing what is known as "selenitic lime," containing about five per cent. of uniformly distributed calcium sulphate, by introducing gaseous sulphur dioxide into the kiln during the burning. Quick and hard setting of the mortar made with this lime, and the possibility of using much more than the usual amount of sand, are the advantages which are reported as attained. It has been ascertained by later experiments that the same results can be obtained by simply adding gypsum to the water used in slaking ordinary lime at the rate of two to five per cent. on the weight of lime treated. The older Roman cement, made from natural hydraulic limestone, has been to a large extent displaced by the improved and greatly extended manufacture of "Portland cement," the latter obtained by intimately mixing in carefully regulated proportion, chalk or other calcareous material on the one hand, with clay or other silicious and aluminous matter on the other, carefully calcining and grinding the mixture. Instead of using water enough in mixing the materials to produce a fluid mud or slip, from which a large part of the water was removed by a tedious process of settling, careful grinding with but little water has been brought into use, and the waste heat from the calcining kilns is utilized in drying off the solid mud so obtained, each charge as dried being transferred to the kiln, and during its calcination furnishing heat for drying the next portion. The great extension of demand for hydraulic cement of late years has led to the suggestion of several new materials for this use, among which one of those attracting for a while much attention was Sorel's oxychloride of magnesium,* prepared by means of the "bittern" of sea water, or the mother liquors from the treatment of Stassfurt carnallite, but none of these materials have to any large extent passed into general use. Recently a cement has been introduced by Ransome, made by burning a mixture of lime and pulverized blast-furnace slag, which has been reported upon in terms of high praise. It is said to set much more rapidly than Portland cement, to attain greater absolute hardness, and to be manufactured at less cost.

STUCCO.

There have been various small changes announced in the methods of hardening gypsum for casts, mouldings, plastering walls, etc. Alum, as employed in Keene's cement, and borax, as used in making the so-called Parian cement, are probably still the chief materials for producing the hardening effect, which is applied not only to the original white gypsum, but also to that with which pigments have been mixed in order to imitate the appearance of marble.

Few inventions in connection with the comfort of our dwellings would have more value than the production of a really satisfactory substitute for plaster on the inner surface of the walls. Such a material should combine lightness, smoothness of surface, moderate porosity, freedom from the brittleness which makes plaster so easily injured, adaptation to the production of decorative effect, capability of being washed, low conducting power for heat, incombustibility—or at any rate considerable power of resisting the progress of fire—and reasonable cheapness. Some of these properties are possessed by the sheets of "muralis" introduced a year or two ago for the purpose in question, which is made by rolling a mixture of linseed oil and ground vegetable fiber on to a strong cotton fabric, but in other respects this invention has not fulfilled the demands of proper wall covering and decoration. The problem is doubtless largely a mechanical one, but involves chemical considerations also.

PRESERVATION OF TIMBER.

For this purpose numerous materials continue from time to time to be proposed. Of late years less extensive use has been made of saline preservatives than of the crude phenols from coal tar, coupled with the external use of coal tar or pitch varnish. Hatzfeld has introduced the use of tan liquor, followed by crude acetate of iron. Experiments by means of hydrostatic pressure, and those of Boucherie, involving the natural capillary action of the sap-bearing vessels of the timber, have led to further progress in the mode of mechanically introducing the preservative fluids of whatever kind into the interior of the wood to be treated. In the light of modern knowledge of the lower forms of life, much value would probably attach to a careful investigation of the direct effect of various supposed poisons upon dry rot, and other moulds and organisms whether belonging to the vegetable or animal kingdom (including teredo, termite, etc.), which led to the decay of timber. Hitherto the selection of materials used has been made pretty much on empirical grounds.

GLUE AND OTHER CEMENTS OF VARIOUS APPLICATION.

In glue-making it has been shown that needlessly protracted boiling and the use of a high temperature produced by high pressure steam greatly injure the quality of the product as to strength and adhesiveness. The practice has, therefore, been introduced with advantage of boiling under pressure equal or superior to that of the atmosphere only until soluble gelatine has been produced, and then boiling down in a vacuum pan until the proper consistence has been reached for solidification in the moulds. It is asserted that bleaching of the scraps of skin, etc., by means of a saturated solution of sulphurous acid before the boiling, not only yields glue of much lighter color and greater clearness and luster, but also produces a swelling up of the material, probably analogous to that which occurs in the "raising" of hide to be tanned, which materially shortens the time required for boiling into glue. It has also of late been proposed to remove fat from the animal matter by preliminary exhaustion with petroleum spirit in order to facilitate the action of the water in the boiling process.

Among the many minor cements which have been brought into use of late years, a few of those most likely to prove permanently valuable, at least for special purposes, are the following:

"Chromated glue," prepared by adding to solution of ordinary gelatine or carpenter's glue chromic acid or potassium pyrochromate, at the rate of about one-fifth the weight of the dry gelatine, this material becoming permanently insoluble in water after it has been used as a cement and exposed to light.

Caseine, from curdled milk, dissolved with the aid of borax.

Glycerine and well-dried litharge, producing a cement which sets even under water, and is said to resist some of the solvents most difficult to manage, such as benzene and carbon disulphide; the proportions recommended are fifty grammes of litharge and six cub. centimeters of a mixture of five parts by volume of glycerine and two of water.

Böttger's cement, made with fine precipitated chalk, stirred into solution of sodium silicate at 33° B., to which pigments may be added, if desired, the mixture hardening in six or eight hours.

The so-called "Spence's metal," a fused mixture of iron pyrites or other metallic sulphides with excess of free sulphur; this material, with a melting point reported as low as 160° C., while presenting a considerable amount of cohesive strength and power of resisting exposure to air and water, with low price, seems worthy of some attention, especially for making the joints of water pipes, etc., although the claims put forward in its behalf on its first announcement were rather extravagant.

Although now far from new, the extremely valuable "Marine glue," of Jeffrey, does not seem to be as well known in this country as it deserves. Prepared by dissolving one part of India-rubber in crude benzene, and mixing with two parts of shellac by the aid of heat, the waterproof character of this cement, in connection with its slight elastic flexibility, the ease with which it is applied when warm, and the promptness with which it sets on cooling, make it a most useful substance in many applications to house construction and furniture, as well as on board ship, where it was originally intended to be chiefly employed.

PIGMENTS FOR HOUSE PAINTERS' USE.

In regard to the most important of these, white lead, there have been several variations of the long used processes of manufacture. Probably the most notable of these is the modern German process, carried out in masonry chambers of considerable dimensions, instead of the small earthen pots of the ancient Dutch method, steam, vapor of acetic acid, air and carbon dioxide being introduced in regulated amounts to act upon thin plates of cast lead. In connection with the processes in which, with a view to extension of surface, lead is used in pulverulent form instead of in plates, may be mentioned the method of pulverizing the metal, patented by Tuttle & McCreary in this country, by means of a jet of high pressure steam driven through a falling stream of molten lead. When pulverulent lead is used for the after manufacture there is always some risk of particles of metal escaping complete corrosion, and, on being ground up, injuring the whiteness of the resulting paint.

Pattinson's white oxychloride of lead is, or was very recently, still manufactured, but does not play a very important part in the general supply.

Zinc white has grown into much more extensive use than formerly, and the production of the oxide represents a valuable industry.

Within the last few years a white oxysulphide of zinc, approximating in composition to $5ZnS.ZnO$, has been brought forward, made by precipitating sulphate or chloride of zinc solution with a soluble sulphide, roasting the product slightly at a cherry red heat, raking out from the furnace into water, grinding finely, and drying. Its beauty of appearance and covering power are very highly spoken of. Mixtures of zinc sulphide with barium sulphate, of generally similar character, have also been placed in the market. The production of lampblack of great purity and beauty, from the smothered combustion of the natural hydrocarbon gas of the petroleum region is a comparatively new industry; this material is, however, too dear for general house painters' purposes, and is more used for choice printing ink than as a pigment. Among the red colors, lead oxychromate has come to be manufactured pretty largely, as a spurious substitute for and an adulterant of vermilion, and under various trade names as an independent pigment. Red, violet, and blue lakes, made with aniline colors, have come into use to some extent. Among blue pigments, the greatest extension of manufacture has occurred with ultramarine, not only as regards the very large quantity now annually turned out, but also the variety of tints obtained, reaching from blue to distinct violet and a tolerable red, as well as the long known green. A paper of last year by Heinze* illustrates the wide variation as to amount of product and cost from the different mixtures of materials in use among ultramarine manufacturers.

Of green colors, Guignet's green (chromic oxide) has come to be made more largely and of much greater brilliancy than formerly, but must still be counted among the dearer pigments. Barium manganate has been introduced as a green pigment, and is said to exhibit much greater permanence than might have been expected from its composition.

VEHICLES FOR PAINTS.

In careful hands the boiling of linseed oil is improved by keeping the temperature down to the lowest necessary point, using steam heat instead of an open fire, though much of the boiled oil of commerce shows the effect of overheating and needless darkening in color. Manganese borate and other substances have come into use as "driers," but no very notable improvement in this direction has been announced. Mixed distemper colors have been rendered capable of preservation for some time before use by addition of carbolic acid in small quantity to the animal size. Soluble glass solution has been used to some extent in the production of a kind of emulsion as a vehicle for paints for outdoor use.

VARNISHES.

Probably the most noteworthy change in the manufacture of varnishes has been the extension of use of dammar and kauri resin, in the treatment of which, however, much remains to be done in order to secure a thoroughly satisfactory product. The large amount of kauri resin obtainable in New Zealand, and its moderate price, render it well worth more careful examination as to its solvents and the conditions under which they should be used. It is said that more information on this subject has already been obtained by certain manufacturers than has been published.

The method of Violette for rendering copal, kauri, etc., more readily soluble by preliminary fusion *in closed vessels* at well-regulated temperature is apparently of real value.

APPENDIX TO BUILDING APPLIANCES.

A.—EXPLOSIVE AGENTS (USED IN BLASTING AND OTHERWISE).

In the economy of gunpowder manufacture the most valuable improvement known to the writer is that introduced at the Confederate Powder Mills, at Augusta, Georgia, by Col. G. W. Rains, in 1862 or '63, namely, incorporation of the materials by a process of steaming. The sulphur and charcoal were severally pulverized and bolted, the niter, pulverized by disturbed crystallization, added to these, and the mass, roughly mixed, was moistened with water and introduced into horizontal cylinders of sheet copper thirty inches long by eighteen inches in diameter. These cylinders revolved slowly on a common axis consisting of a heavy brass tube three inches in diameter, perforated within the cylinders by a number of holes one-eighth inch diameter. High pressure steam was introduced through this tube, raising the temperature to the boiling point, while the water produced by condensation, added to that originally used to moisten the materials, reduced them to a semiliquid slush, which was run out of the cylinders after about eight minutes' rotation. On cooling, this mud became a damp solid cake, the niter, which in the state of boiling hot saturated solution had entered the minutest pores of the charcoal, now recrystallizing. The cake so produced was transferred to the incorporating mills, and under five ton rollers was in an hour brought to the condition of finished mill cake, ready to be cooled and granulated, while without the steaming process four hours' incorporation in the mills had previously been necessary to produce powder of the same first-class character. The capacity for work of the mills was thus practically quadrupled, the thorough saturation of the charcoal with niter being accomplished by the steaming, while it remained for the rollers merely to complete the mixture of the whole mass and to give the required density to the mill cake. The enormous increase in the size of ordnance has led to much greater pains being taken in regulating the density of the press cake made from the crushed mill cake by hydraulic pressure, and much attention has been given to producing grains, pellets, and prisms of finished powder of determinate size and shape. As regards the proportions in which the materials of gunpowder are used, the researches of Noble and Abel have shown that much less difference in the work done on explosion is caused by very considerable variation of composition than would have been previously supposed likely, the production of a higher temperature on explosion being attended with the formation of a less volume (at normal temperature and pressure) of permanent gases, and *vice versa*.

The investigations of Lenk and Abel have determined the proper conditions for the manufacture, storage, and use of gun-cotton, have rendered it a practically manageable explosive, especially in the form of compressed pulp, and one of special value in certain cases. The latest modification proposed in the process of making it is that of Aimé Girard,* who moistens the vegetable fiber to be treated with a very weak solution of sulphuric or hydrochloric acid, heats to 50° or 80° C., or allows the moistened material to stand at common temperature for some weeks, or instead of the liquid acid uses a current of moist gaseous hydrochloric acid, finally washing out thoroughly with water. The "hydrocellulose" thus formed is acted upon with concentrated nitric acid in the usual way, and a product is obtained which is extremely friable, and which after reduction to impalpable powder is said to resemble dynamite in its simple fusion on contact with flame (?) and in the extreme violence of its explosion by a shock.

In making nitroglycerol it has been found that the inconvenience and danger resulting from rise of temperature in the mixture may be obviated by first treating the glycerol at 30° C. with three times its weight of concentrated sulphuric acid, forming sulphoglyceric acid, cooling, and adding to separately mixed and cooled nitric and sulphuric acid. The reaction is attended with little heating, is not complete until twenty-four hours or so after mixture, and produces a distinct layer of nitroglycerol, to be siphoned off and washed. While dynamite is still largely used, consisting of nitroglycerol given solid form by mixture with inert mineral matter, there have been numerous more or less successful attempts to produce energetic explosives by substituting for such mineral matter (infusorial silica) a solid substance or substances capable of contributing to the production of useful effect. The most interesting of these until recently was the "glyoxaline" of Abel, consisting of ordinary guncotton soaked with nitroglycerol, both substances being energetic explosives, and the latter supplying the surplus oxygen which the former needs to render complete combustion possible. To this mixture a still more convenient form has recently been given, the so-called "explosive gelatine" of Nobel, prepared by dissolving about seven per cent. of photographer's pyroxyline (soluble gun-cotton) in nitroglycerol to a jelly, with which may advantageously be mixed ten per cent. of the most highly explosive trinitrocellulose. This new material is free from the disadvantage of the nitroglycerol separating, as from dynamite. For some purposes it is modified by the addition of a little camphor.

Although of subordinate importance, the picrates should be mentioned as comparatively recent additions to the list of standard explosives.

Our general knowledge in regard to the phenomena of explosion has received important additions from the long continued researches of Abel, Noble, Champion, and Pellet, the information obtained having already led to valuable applications in practice, and serving to point out clearly lines for future investigation. Among the chief subjects already examined are: the distinction between detonative explosion, developed by sudden mechanical shock (as from a separate initiative explosion), and inflammatory explosion, brought about by the application of a burning body to some part of the explosive material; the effect of complete inclosure within strong walls, or simple surrounding of the explosive with air or other readily mobile material; the conditions of transmission of detonative explosion from one mass to another of the same explosive agent, or from an explosive of one kind to one of different nature; the influence of the physical state and mechanical condition of the explosive; the phenomena of explosion in a mass saturated with or surrounded by water; and the chemical character of the products, the temperature and the gaseous tension developed under different circumstances of explosion.

* Proposed also as a substitute for gypsum in making casts, etc., and as the cementing material in the production of artificial stone.

* *Polytechn. Jour.*, 231; 366.

* *Comptes Rendus*, 88, 1322, and 89, 170.

B.—DISINFECTANTS.

The increased attention bestowed of late years upon sanitary matters has led to the manufacture, on quite a large scale, of numerous materials claiming to be valuable as disinfectants. The real value of these, when genuine, it is not easy accurately to estimate in the present imperfect condition of our knowledge as to the nature of the evils to be combated and the manner in which they should be attacked. Unfortunately, in too many cases there has been extensive adulteration of substances which, in their proper condition, might fairly be accepted with some confidence, and in too many cases also there has been ignorance displayed in the use as well as in the choice of materials for this purpose. As a single illustration of the need existing for much fuller investigation of the subject of disinfecting materials and methods, the recent observations of Dianin* may be referred to. It has been generally held that carbolic acid and chloride of lime, separately useful as disinfectants, should be viewed as "incompatibles," the former liable to be destroyed by the latter, with loss of activity on the part of both. Dianin finds that if these two materials be mixed, trichlorphenol is at once produced with but little of the di and monochlor derivatives, and that the mixture, representing essentially the calcium compound of trichlorphenol, possesses notably greater antiseptic activity than either of the original substances taken by itself. Among the many individual points calling for accurate and unbiased scientific investigation, may be instanced the effects producible upon the lower forms of living organisms by very low temperatures, although this a question for the physicist and biologist instead of the chemist. The extension given to our command of low temperatures by the various forms of the modern ice-machine has increased the tendency to rely upon refrigeration as a disinfecting process, while experiments made upon the vitality of seeds of the higher orders of plants, after exposure to extraordinary cold, have not, so far as parallel inferences may be drawn from them, been by any means encouraging as to the destruction of the living organisms of simple structure whose important relation to the propagation of disease we have so much reason for believing to exist.

Among the chief steps of progress in recent years in regard to the industrial production of disinfecting materials, may be noted the great increase in the manufacture of phenol and cresol from coal tar (as also their sodium and calcium compounds), and their production in a state of far greater purity than formerly, the introduction upon a smaller, but still a commercial scale, of thymol and other of the higher phenols (the value of the special claims made in favor of which may still be considered open to discussion), the preparation in a very large way of salicylic acid by Kolbe's synthetic process, the manufacture of oxidized products from turpentine through which air is passed in the presence of water, the comparatively cheap production of the permanganates by the economical arrangements of Tessié du Motay and others, the use of bromine vapor, the manufacture of certain saline substances, such as aluminum chloride and bromide, in large quantity and at low price, with special advantages as to some details of their application, but of moderate or doubtful activity, and the supply of some new porous absorbents, such as Stanford's seaweed charcoal, usefully available for some purposes of disinfection, within such distances from the seat of their production as are not too great to allow of moderate charges for transportation.

J. W. MALLET.

ON THE VISCOSITY OF GASES AT HIGH EXHAUSTIONS.†

By WILLIAM CROOKES, F.R.S.

BY the viscosity or internal friction of a gas, is meant the resistance it offers to the gliding of one portion over another. In a paper read before the British Association in 1859, Maxwell‡ presented the remarkable result that on theoretical grounds the coefficient of friction, or the viscosity, should be independent of the density of the gas, although at the same time he states that the only experiments he had met with on the subject did not seem to confirm his views.

An elaborate series of experiments were undertaken by Maxwell to test so remarkable a consequence of a mathematical theory; and in 1866, in the Bakerian lecture for that year, § he published the results under the title of "The Viscosity or Internal Friction of Air and other Gases." He found the coefficient of friction in air to be practically constant for pressures between 30 in. and 0·5 inch; in fact numbers calculated on the hypothesis that the viscosity was independent of the density agreed very well with the observed values.

The apparatus used by Maxwell was not of a character to admit of experiments with much lower pressures than 0·5 inch.

Maxwell's theory, that the viscosity of a gas is independent of the density, presupposes that the mean length of path of the molecules between their collisions is very small compared with the dimensions of the apparatus; but inasmuch as the mean length of path increases directly with the expansion, while the distance between the molecules only increases with the cube root of the expansion, it is not difficult with the Sprengel pump to produce an exhaustion in which the mean free path is measured by inches, and even feet, and at exhaustions of this degree it is probable that Maxwell's law would not hold.

The experiments recorded in this paper were commenced early in 1876, and have been continued to the present time. In November, 1876, the author gave a note to the Royal Society on some preliminary results. Several different forms of apparatus have since been used one after the other, with improvements and complexities suggested by experience or rendered possible by the extra skill acquired in manipulation. The earlier observations are now of little value, but the time spent in their prosecution was not thrown away, as out of those experiments has grown the very complicated apparatus now finally adopted.

The Viscosity Torsion Apparatus with which all the experiments here given have been performed, is a very complicated instrument, and cannot be well understood without the accompanying drawings. It consists essentially of a glass bulb, blown with a point at the lower end, and sealed on to a long narrow glass tube. In the bulb is suspended a plate of mica, by means of a fine fiber of glass, 26 inches long, which is sealed to the top of the glass tube, and hangs vertically along its axis. The plate of mica is ignited and lamp-blacked over one-half. The tube is pointed at the upper end, the upper and lower points are 46 inches apart, and are accurately in the prolongation of the axis of the tube. Sockets are firmly fixed to a solid support, so that when the tube and bulb are clamped between them they are only able to move around the vertical axis. The glass fiber being only connected with the tube at the top, rotating the tube on its axis communicates torsion to the fiber, and sets the mica plate swinging on the same axis without giving it any pendulous movement. The diameter of the fiber is about 0·001 inch. The viscosity apparatus is connected to the pump by a flexible glass spiral, so as to allow the apparatus to rotate on the pivots and at the same time to be connected to the pump altogether with sealed glass joints. An arm working between metal stops, limits the rotation to the small angle only which is necessary.

The torsional movement given to the mica plate, by the light of the candle shining on it or by the rotation of the bulb and tube on its axis by the movement of the arm between the stops, is measured by a beam of light from a lamp reflected from a mirror to a graduated scale.

The pump employed has already been described. The measuring apparatus is similar to that described by Prof. McLeod* before the Physical Society, June 13, 1874. As it contains several improvements shown by experience to be necessary when working at very high vacua, a detailed description is given in the paper.

When taking an observation the arm is moved over to the stop, and in a few seconds allowed to return to its original position by the action of a spring. This movement rotates the viscosity apparatus through a small angle, and sets the mica plate vibrating, the reflected line of light traversing from one side of the scale to the other in arcs of diminishing amplitude till it finally settles down once more at *zero*.

The observer watching the moving index of light records the scale number reached at the extremity of each arc. The numbers being alternately on one and the other side of zero are added two by two together, to get the value of each oscillation. The logarithms of these values are then found, and their differences taken; the mean of these differences is the logarithmic decrement per swing of the arc of oscillation. For the sake of brevity this is called the log. dec.

A very large number of experiments have been made on the viscosity of air and other gases. Observations have been taken at as high an exhaustion as 0·02 M, but at these high points they are not sufficiently concordant to be trustworthy. The pump will exhaust to this point without difficulty if a few precautions are taken, but at this low pressure the means of measuring fail in accuracy.

The precautions which experience shows to be necessary when exhausting to the highest points are fully described in the paper.

VISCOSITY OF AIR.

The mean of a very large number of closely concordant results gives us the log. decrement for air for the special apparatus employed, at a pressure of 760 millims. of mercury and a temperature of 15° C., the number 0·1124. According to Maxwell the viscosity should remain constant until the rarefaction becomes so great that we are no longer at liberty to consider the mean free path of the molecules as practically insignificant in comparison with the dimensions of the vessel.

The author's observations show that this theoretical result of Maxwell's is at least approximately and may be accurately true in air up to such exhaustions as are above referred to; and that at higher exhaustions the viscosity falls off, as it might be expected to do according to theory.

The results are embodied in a table and diagrams.

The first half of the table gives the viscosity of air, in so far as it is represented by the log. dec., at pressures intermediate between 760 millims. and 0·76 millim. (1,000 millionths of an atmosphere). In order to avoid the inconvenience of frequent reference to small fractions of a millimeter, the millionth of an atmosphere† (=M) is now taken as the unit instead of the millimeter. The second half of the table is therefore given in millionths, going up to an exhaustion of 0·02 millionth of an atmosphere.

Starting from the log. dec. 0·1124 at 760 millims., the viscosity diminishes very regularly but at a somewhat decreasing rate. Between 50 millims. and 3 millims. the direction is almost vertical, and a great change in the uniformity of the viscosity curve commences at a pressure of about 3 millims. At this point the previous approximation to, or coincidence with, Maxwell's law begins to fail, and further pumping considerably reduces the log. decrement.

From 1,000 M the diminution of viscosity is very slight until the exhaustion reaches about 250 M; after that it gets less with increasing rapidity, and falls away quickly after 35 M is reached.

The curves of increasing mean free path and diminishing viscosity closely agree. This agreement is more than a mere coincidence, and is likely to throw much light on the cause of viscosity of gases.

In the table is also given the measurements of the repulsion exerted on the blackened end of the mica plate by a candle flame placed 500 millims. off. The repulsion due to radiation commences just at about the same degree of exhaustion where the viscosity begins to decline rapidly, and it principally comes in at the exhaustions above 1,000 M.

The close agreement between the loss of viscosity and the increased action of radiation is very striking up to the 35 millionth, when the repulsion curve turns round and falls away as rapidly as the viscosity.

Experiments are next described on the resistance of air to the passage of an induction spark.

Since the publication of the author's researches on the phenomena presented by the passage of the induction discharge through high vacua, the present results—which, although never published, precede by a year or two those just mentioned—have lost much of their interest.

The phenomena at the very high exhaustion of 0·02 M may be of interest. With a coil giving a spark 85 millims. long, no discharge whatever passes. On increasing the battery power till the striking distance in air was 100 millims. the spark occasionally passed through as an intermittent flash, bringing out faint green phosphorescence on the glass round the end of the — pole.

On one occasion the author obtained a much higher exhaustion than 0·02 M It could not be measured, but from the repulsion by radiation and the low log. dec. it was probably about 0·01 M. The terminals of the vacuum tube and wires leading to them were well insulated, and the full power of a coil giving a 20 inch spark was put on to it. At first nothing was to be seen. Then a brilliant green light flashed through the tube, getting more and more frequent. Suddenly a spark passed from a wire to the glass tube, and broke it, terminating the experiment.

Since these experiments vacua have frequently been got as high, and even higher, but the author has never seen one that would long resist the 20 inch spark from his large coil.

VISCOSITY OF OXYGEN.

The series of experiments with air show a complete history of its behavior between very wide limits of pressure. It became interesting to see how the two components of air, oxygen and nitrogen, would behave under similar circumstances. Experiments were therefore instituted exactly as in the case of dry air, but with the apparatus filled with pure oxygen.

The results are given in the form of tables and plotted as curves on diagrams.

The figures show a great similarity to the air curve. Like it the log. dec. sinks somewhat rapidly between pressures from 760 millims. to about 75 millims. It then remains almost steady, not varying much till a pressure of 16 millims. is reached. Here, however, it turns in the opposite direction, and increases up to 1·5 millims. It then diminishes again, and at higher exhaustions it rapidly sinks. This increase of viscosity at pressures of a few millimeters has been observed in other gases, but only to so small an extent as to be scarcely beyond the limits of experimental error. In the case of oxygen, however, the increase is too great to be entirely attributable to this cause.

Oxygen has more viscosity than any gas yet examined. The viscosity of air at 760 millims. being 0·1124, the proportion between that of air and oxygen, according to these results, is, 1·1185.

This proportion of 1·1185 holds good (allowing for experimental errors) up to a pressure of about 20 millims. Between that point and 1 millim. variations occur, which have not been traced to any assignable cause: they seem large to be put down to "experimental errors." The discrepancies disappear again at an exhaustion of about 1 millim., and from that point to the highest hitherto reached the proportion of 1·1185 is fairly well maintained.

VISCOSITY OF NITROGEN.

The proportion between the viscosities of nitrogen and air at a pressure of 760 millims. is, according to these experiments, 0·9715.

A comparison of the air curves with those given by oxygen and nitrogen gives some interesting results. The composition of the atmosphere is, by bulk,

Oxygen........................	20·8
Nitrogen........................	79·2
	100·0

The viscosity of the two gases is almost exactly in the same proportion: thus at 760 millims—

$$\frac{20{\cdot}8 \text{ } vis. \text{ O} + 79{\cdot}2 \text{ } vis. \text{ N}}{100} = vis. \text{ air},$$

$$\frac{20{\cdot}8\,(0{\cdot}1257) + 79{\cdot}2\,(0{\cdot}1092)}{100} = \text{ "}$$

$$\frac{2{\cdot}61456 + 8{\cdot}64072}{100} = 0{\cdot}11255,$$

a result closely coinciding with 0·1124, the experimental result for air. Up to an exhaustion of about 30 M the same proportion between the viscosities of air, oxygen, and nitrogen is preserved with but little variation. From that point divergence occurs between the individual curves of the three gases.

Observations on the spectrum of nitrogen are next given.

The curve of Repulsion exerted by Radiation is plotted on the diagrams. It is much lower than in oxygen or air, and sinks rapidly after the maximum is passed.

VISCOSITY OF CARBONIC ANHYDRIDE.

The curves of this gas are given in diagrams plotted from the observations. At first the curve seems to follow the same direction as the air curve. But at a pressure of about 620 millims. it slopes more rapidly till the pressure is reduced to about 50 millims., when the curve again takes the direction of the air curve. The total diminution between 760 millims. and 1 millim. is nearly double that of air.

The proportion between the viscosity of carbonic anhydride and air at 760 millims. is 0·9208.

VISCOSITY OF CARBONIC OXIDE.

The results with this gas are remarkable as showing an almost complete identity with those of nitrogen both in position and shape. The viscosity at 760 millims. is in each case 0·1092.

Like that of nitrogen, the curve of carbonic oxide is seen to be vertical, *i. e.*, assuming the curve to represent the viscosity, the gas obeys Maxwell's law, at pressures between 90 millims. and 3 millims. The straight portion in nitrogen is at a little higher pressure, between 100 millims. and 6 millims.

The curve of repulsion resulting from radiation is lower in carbonic oxide than in any other gas examined, and, unlike the other gases, there is no sudden rise to a maximum at about 40 M. At lower exhaustions the curve is, however, higher than it is in nitrogen.

VISCOSITY OF HYDROGEN.

It has been found that hydrogen has much less viscosity than any other gas; the fact of the log. dec. not decreasing by additional attempts at purification is the test of its being free from admixture. This method of ascertaining the purity of the gas, by the uniformity of its viscosity coefficient at 760 millims., is more accurate than collecting samples and analyzing them eudiometrically.

Several series of observations in hydrogen have been taken. For a long time it was considered that hydrogen, like other gases, showed the same slight departure from Maxwell's law of viscosity being independent of density that appeared to be indicated with other gases; for the log. dec. persistently diminished as the exhaustion increased, even at such moderate pressures as could be measured by the barometer gauge. Had it not been that the rate of decrease was not uniform in the different series of observations, it might have been considered that this variation from Maxwell's law was due to some inherent property of all gases. After working at the subject for more than a year, it was discovered that the discrepancy arose from a trace of water obstinately held by the hydrogen. Since discovering this property, extra precautions (already described at the commencement of this paper) have been taken to dry all gases before entering the apparatus.

* Chem. Centralblatt., Nov. 3, 1880, 689; quoting from a Russian journal

† Abstract of a Paper read before the Royal Society, February 17, 1881.

‡ Phil. Mag., 4th Ser., vol. xix., p. 31.

§ Phil. Trans., 1866, Part 1, p. 249.

* Philosophical Magazine, vol. xlviii., p. 110, August, 1874.

† 1 M=0·00076 millim.; 1315·789 M=1 millim.

The remarkable character of hydrogen is the uniformity of resistance which it presents. It obeys Maxwell's law almost absolutely up to an exhaustion of about 700 M, and then it commences to break down. Up to this point the line of viscosity is almost perfectly vertical. It then commences to curve over, and when the mean free path assumes proportions comparable with the dimensions of the bulb, and approaches infinity, the viscosity curve in like manner draws near the zero line.

The repulsive force of radiation is higher in hydrogen than in any other gas. It commences at as low an exhaustion as 14 millims., but does not increase to any great extent till an exhaustion of 200 M is attained; it then rises rapidly to a maximum at between 40 and 60 M, after which it falls away to zero. The maximum repulsion exerted by radiation in hydrogen is to that in air as 70 to 42·6. This fact is now utilized in the construction of radiometers and similar instruments when great sensitiveness is required.

Taking the viscosity of air at 760 millims. as 0·1124, and hydrogen as 0·0499, the proportion between them is 0·4439.

THE SPECTRUM OF HYDROGEN.

The red line (λ=6562), the green line (λ=4861), and the blue line (λ=4340) are seen at their brightest at a pressure of about 3 millims., and after that exhaustion they begin to diminish in intensity. As exhaustion proceeds a variation in visibility of the three lines is observed. Thus at 36 millims. the red line is seen brightly, the green faintly, while the brue line cannot be detected. At 15 millims. the blue line is seen and the three keep visible till an exhaustion of 418 M is reached, when the blue line becomes difficult to see. At 38 M only the red and green lines are visible, the red being very faint. It is seen with increasing difficulty up to an exhaustion of 2 M, when it can be seen no longer. The green line now remains visible up to an exhaustion of 0·37 M, beyond which it has not been seen.

It is worthy of remark that although when working with pure hydrogen the green line is always the last to go, it is not the first to appear when hydrogen is present as an impurity in other gases. Thus when working with carbonic anhydride insufficiently purified, the red hydrogen line is often seen, but never the green or the blue line.

INFLUENCE OF AQUEOUS VAPOR ON THE VISCOSITY OF AIR.

In the foregoing experiments many discrepancies were traced to the presence of moisture in the gas. The influence of aqueous vapor does not appear to be great when present in moderate amount in gas of normal density, but at high exhaustions it introduces errors which interfere with the uniformity of the results. A series of experiments were accordingly undertaken to trace the special action of aqueous vapor when mixed with air.

Up to a pressure of about 350 millims. the presence of aqueous vapor has little or no influence on the viscosity of air. The two curves are in fact superimposed. At this point, however, divergence commences, and the curve rapidly bends over, the viscosity falling from 0·0903 to 0·0500 between 50 and 7 millims. pressure. Here it joins the hydrogen curve, and between 7 millims. and 1 millim. they appear to be identical.

These results are partly to be explained by the peculiar action of water vapor in the apparatus. At the normal pressure the amount of aqueous vapor present in the air, supposing it to be saturated, is only about 13 parts in a million, and the identity of the log dec. with that of dry air shows that this small quantity of water has no appreciable action on the viscosity. When the pump is set to work the air is gradually removed, while the aqueous vapor is kept supplied from the reservoir of liquid. As the exhaustion approaches the tension of aqueous vapor, evaporation goes on at a greater rate, and the vapor displaces the air with increasing rapidity; until after the pressure of 12·7 millims. is passed, the aqueous vapor acts as a gas, and, being constantly supplied from the reservoir of water (as long as it lasts), washes out all the air from the apparatus, the log. dec. rapidly sinking to that of pure water gas.

This explanation requires that the viscosity of pure aqueous vapor should be the same as that of hydrogen, at all events between 7 millims and 1 millim. pressure. The facts can, however, be explained in another way. During the action of the Sprengel pump sufficient electricity is sometimes generated to render the fall tubes luminous in the dark. It is conceivable that under such electrical influence the falling mercury may be able to decompose aqueous vapor at these high exhaustions, with formation of oxide of mercury and liberation of hydrogen. Of these two theories the latter appears to be the more probable.

The presence of water vapor shows itself likewise in the very slight amount of repulsion produced by radiation. Repulsion commences in air at a pressure of 12 millims., while at a higher exhaustion the maximum effect rises to over 40 divisions. Here, however, repulsion does not begin till the exhaustion is higher than the barometer gauge will indicate, while the maximum action after long-continued pumping is only 9 divisions.

VISCOSITY OF KEROSOLINE VAPOR.

The rapid diminution of viscosity in the last experiment after reaching the pressure of 400 millims. is probably due to the aqueous vapor in the air being near its liquefying point. It was thought advisable to test this hypothesis by employing a somewhat less easily condensible vapor, which could be introduced into the apparatus without any admixture of air. An experiment was accordingly tried with a very volatile hydrocarbon, commercially known as kerosoline, boiling at a little above the ordinary temperature. The vapor of this body was introduced into the well-exhausted apparatus, when the gauge at once sank 82·5 millims. After the usual precautions to eliminate air a series of observations were taken.

The loss of viscosity is more rapid than with any other gas examined except aqueous vapor. Conversely a very great increase of viscosity occurs on increasing the pressure from 8 to 82·5 millims. The explanation of this is that the vapor of kerosoline is very near its liquefying point, and therefore very far from the state of a "perfect" gas.

The negative bend in the curve at about 10 millims. pressure, already noticed with other gases, is strongly marked with this hydrocarbon vapor.

DISCUSSION OF RESULTS.

When discussing the viscosity results obtained with the different gases experimented with, the author gives the following approximate comparison of viscosities, such as is afforded by a comparison of the log. decs. of each gas and that of air, comparing the ratio with that obtained by Graham, Kundt and Warburg, and Maxwell.

	Graham.	Kundt & Warburg.	Maxwell.	Crookes.
Air	1·0000	1·0000	1·0000	1·0000
Oxygen...............	1·1099	—	—	1·1185
Nitrogen	0·971	—	—	0·9715
Carbonic oxide	0·971	—	—	0·9715
Carbonic anhydride...	0·807	0·806	0·859	0·9208
Hydrogen.............	0·4855	0·488	0·5156	0·4439

Graham's numbers are the theoretical results deduced from his experiments on transpiration of gases. They are, he says,* the numbers to which the transpiration times of the gases approximate and in which they have their limit. Graham concludes that the "times of oxygen, nitrogen, carbonic oxide, and air are directly as their densities, or equal *weights* of these gases pass in equal times. Hydrogen passes in half the time of nitrogen, or twice as rapidly for equal volumes. The result for carbonic acid appears at first anomalous. It is that the transpiration time of the gas is inversely proportional to its density when compared with oxygen."

The proportion between air and oxygen, nitrogen or carbonic oxide, is not very different at any degree of exhaustion to that which it is at 760 millims. Carbonic anhydride, however, is different; the proportion between it and air holds good between 760 and 650 millims. Then it gets lower and lower as the pressure sinks, until 50 or 55 millims. is reached, when the proportion between it and air again becomes constant.

Hydrogen, however, is entirely different to the other gases; its log. dec. remains the same to a very high exhaustion, and that of other gases sinking, it is evident that the proportion between this gas and any other is different for each pressure.

It must not be forgotten that the pressure of 760 millims. is not one of the constants of nature, but is a purely arbitrary one, selected for our own convenience when working near the level of the sea. In the diagrams accompanying the paper the author has started from this pressure of 760 millims., and has given the log. dec. curves which approximately represent the viscosities through a wide range of exhaustion. But the curves might also be continued, working downwards instead of upwards. From the shape and direction in which they cut the 760 line it is reasonable to infer their further progress downwards, and we may assume that an easily liquefiable gas will show a more rapid increase in viscosity than one which is difficult to liquefy by pressure. For instance, hydrogen, the least condensible of all gases, shows no tendency to increase in log. dec. by pressure. Oxygen and nitrogen, which are only a little less difficult to condense than hydrogen, show a slight increase in log. dec. Carbonic anhydride, which liquefies at a pressure of 56 atmospheres at 15° C., increases so rapidly in log. dec. that at this pressure it would have a log. dec. of about 1·3, representing an amount of resistance to motion that it is difficult to conceive anything of the nature of gas being capable of exerting.

Kerosoline vapor is rendered liquid by pressure much more readily than carbonic anhydride. Its curve shows a great increase in density for a very slight access of pressure.

Again aqueous vapor is condensible to the liquid form with the greatest readiness; and the almost horizontal direction of the curve representing aqueous vapor mixed with air carries out the hypothesis.

It follows, then, that Maxwell's law holds good for perfect gases. The disturbing influence spoken of in the commencement of this paper as occasioning a variation from Maxwell's law, is the tendency to liquefaction, which prevents us from speaking of any gas as "perfect," and which hinders it from obeying Boyle and Mariotte's law. The nearer a gas obeys this law the more closely does it conform to Maxwell's law.

Maxwell's law was discovered as the consequence of a mathematical theory. It presupposes the existence of gas in a "perfect" state—a state practically unknown to physicists, although hydrogen gas very nearly approaches that state. An ordinary gas may be said to be bounded, as regards its physical state, on the one side by the subgaseous or liquid condition, and on the other side by the ultra-gaseous condition. A gas assumes the former state when condensed by pressure or cold, and it changes to the latter state when highly rarefied. Before actually assuming either of these states there is a kind of foreshadowing of change, with partial loss of gaseity. When the molecules, by pressure or cold, are made to approach each other more closely, they begin to enter the sphere of each other's attraction, and therefore the amount of pressure or cold necessary to produce a certain density is less than the theoretical amount by the internal attraction exerted on each other by the molecules. The nearer the gas approaches the point of liquefaction the greater is the attraction of one molecule to another, and the amount of pressure required to produce any given density will be proportionally less than that theoretically required by a "perfect" gas.

THE ULTRA-GASEOUS STATE OF MATTER.

After some theoretical considerations respecting the viscosity of gases the author concludes with the detailed statement of his theory of the existence of an ultra-gaseous state of matter.

A consideration of the curves of the gases, especially hydrogen, which are given in the paper, will confirm the supposition that a gas, as the exhaustions become extreme, gradually loses its gaseous characteristics, and passes to an ultra-gaseous state.

An objection has been raised touching the existence of ultra-gaseous matter in highly exhausted electrical tubes, that the special phenomena of radiation and phosphorescence which the author has considered characteristic of this form of matter can be made to occur at much lower pressures than that which exhibits the maximum effects. For the sake of argument let us assume that the state of ultra gas with its associated phenomena is at the maximum at a millionth of an atmosphere. Here the mean free path is about 4 inches long, sufficient to strike across the exhausted tube. But it has been shown by many experimentalists that at exhaustions so low that the contents of the tube are certainly not in the ultra gaseous state, the phenomena of phosphorescence can be observed. This circumstance had not escaped the author's notice. In his first paper on the "Illumination of Lines of Molecular Pressure and the Trajectory of Molecules,"† the author drew attention to the fact that a molecular ray producing green phosphorescence can be projected 102 millimeters from the negative pole when the pressure is as high as 0·324 millim., or 427 M. In this case the mean free path of the molecules is 0·23 millim.; and it is not surprising that with more powerful induction discharges, and with special appliances for exalting the faint action to be detected, the above-named phenomena can be produced at still higher pressures.

It must be remembered that we know nothing of the *absolute* length of the free path or the *absolute* velocity of a molecule; these may vary almost from zero to infinity. We must limit ourselves to the *mean* free path and the *mean* velocity, and all that these experiments show is that a few molecules can travel more than a hundred times the *mean* free path, and with perhaps a corresponding increase over the *mean* velocity, before they are stopped by collisions. With weak electrical power the special phosphorogenic action of these few molecules is too faint to be noticed; but by intensifying the discharge the action of the molecules can be so increased as to render their presence visible. It is also probable that the absolute velocity of the molecules is increased so as to make the mean velocity with which they leave the negative pole greater than that of ordinary gaseous molecules. This being the case, they will not easily be stopped or deflected by collisions, but will drive through obstacles, and so travel to a greater distance.

If this view is correct, it does not follow that gas and ultra gas can coexist in the same vessel. All that can be legitimately inferred is, that the two states insensibly merge one into the other, so that at an intermediate point we can by appropriate means exalt either the phenomena due to gas or to ultra gas. The same thing occurs between the states of solid and liquid, and liquid and gas. Tresca's experiments on the flow of solids prove that lead and even iron, at the common temperature, possess properties which strictly appertain to liquids, while Andrews has shown that liquid and gas may be made to merge gradually one into the other, so that at an intermediate point the substance partakes of the properties of both states.

* Loc. cit., pp. 178, 179.

† Phil. Trans., Part 1, 1879. The Bakerian Lecture.

NEW ELECTROLYTIC RESULTS.

By E. F. SMITH.

ON passing the current from a potassium chromate battery of two elements through an aqueous solution of uranium acetate, bright yellow uranium sesquioxide was separated at the zinc pole and gradually turned black. No uranium remained in the solution. The most favorable results were obtained on dissolving 1,000 grammes of a salt of uranium in 10 c. c. water. The complete precipitation of the uranium and its conversion into the black form requires three hours. The black compound is uranic uranous oxide, containing 81·13 per cent. of metallic uranium. This process is well adapted for the analysis of the uranium silicates. Ammonium molybdate is precipitated by the current, but the process requires many hours for its completion. Neutral solutions of tungstates are not affected by the current. If boiled with acetic acid there is produced a small quantity of a blue precipitate, which turns brown on prolonged action, but become blue again on exposure to the air. In solutions of the vanadiates the current produces only a change of color. Vanadium sulphate yelds a deposit of small, deep brown flakes. Didymium is imperfectly precipitated at the positive pole. From the salts of cerium the yellow Ce_2O_4 hydrate is thrown down, incompletely and slowly.

SEPARATION OF CADMIUM AND ZINC.

By A. YVER.

IN a memoir inserted in the *Annales de Chimie et de Physique* (Series 4, vol. 30, p. 351), M. Riche described a process for the determination of zinc, either by the decomposition of the acetate or by the electrolysis of the solution containing sulphuric acid. Several researches on the same subject have since been published by different authors. MM. Beilstein and Jawein, while confirming the results of Riche, employ the following process: The nitric or sulphuric solution of zinc is mixed with caustic soda until precipitation ensues, and then with potassium cyanide till the precipitate is redissolved; the electrolysis is then effected with four Bunsen elements. The determination of cadmium has been effected by the same chemists under the same circumstances by means of the current from three elements. M. Millot has recently given a process for the determination of zinc by the electrolysis of a solution of this metal in potassa. M. Edgar Smith obtains a precipitate of metallic cadmium by passing a strong current through a solution of the acetate. These procedures have the defect of not serving for the separation of cadmium and zinc, as the two metals are precipitated simultaneously. They may be separated as follows: The solution containing the two metals in the state of acetates is mixed with two or three grammes sodium acetate, and a few drops of acetic acid. The current from two Daniell elements is then passed through the solution as described by M. Riche in his memoir. The cadmium alone is deposited in a crystalline layer at the negative pole, the zinc remaining in solution. The process requires the aid of heat, and requires three to four hours for quantities of 0·180 gramme to 0·210 gramme cadmium, and as much zinc. The deposit is effected in the crucible, and the liquid is then drawn off and serves for the determination of the zinc, according to M. Riche's process. The deposit is washed first with water, then with alcohol, dried, and weighed. If the zinc and cadmium are present as sulphates the author recommends precisely the same method. Or the sulphuric solution may be mixed with ammonia and ammonium sulphate.

THE SENSITIVENESS OF THE ROOT-TIP OF THE SEEDLING.

WE believe that there is no structure in plants more wonderful, as far as its functions are concerned, than the tip of the radicle. If the tip be lightly pressed or burnt or cut, it transmits an influence to the upper adjoining part, causing it to bend away from the affected side; and what is still more surprising, the tip can distinguish between a slightly harder and a softer object by which it is simultaneously pressed on opposite sides. If, however, the radicle is pressed by a similar object, a little above the tip, the pressed part does not transmit any influence to the more distant parts, but bends abruptly toward the object. If the tip perceives the air to be moister on one side than the other, it likewise transmits an influence to the upper adjoining part, which bends toward the source of moisture. When the tip is excited by light, the adjoining part bends from the light; but when excited by gravitation, the same part bends toward the center of gravity.—*Darwin's "The Power of Movement in Plants."*

PROCESS FOR BLEACHING COTTON IN THE DRY WAY BY THE VAPORS OF CHLOROFORM CHARGED WITH CHLORINE.

By Albert Engler.

This invention relates to the bleaching of spun cotton, especially in cops or in bobbins. The latter are placed in a special receiver lined with lead, or enameled tin, about three yards long, two high, and one and a half deep, holding about 330 lb. This receiver is connected by means of an India-rubber tube with an apparatus in which vapors of chloroform are generated by means of the following mixture:

Quicklime	1 part.
Chloride of lime	1 "
Alcohol or acetic acid	1 "
Water	4 parts.

Sulphuric acid is of course added.

The choloroform vapors are passed into the receiver to the cotton and allowed to act upon it for two hours at the pressure of two atmospheres, when the bleaching is complete.

A mixture of hydrogen, carbonic acid, and vapor of sulphuric acid is then generated in a Woolfe's bottle. [The sulphuric acid will, we presume, have to be produced in a retort in the usual manner, as it could not be formed to advantage by the dilute acid required to liberate hydrogen and carbonic acid.] This mixture of gases and vapors is passed into the chest containing the cotton, and is said in a short time completely to remove every smell of chloroform.—*Industrie Blätter.*

[Supposing this process to be satisfactory, we fear it could not be worked in England owing to the cost of the alcohol.]—*Chem. Review.*

BLEACHING AND DYEING STRAW HATS.

Put the straw hats into a pan of boiling water and let them steep over night. The next morning make up a strong soap beck and brush them well therein. Put them in the stove without rinsing for twenty-four hours, then rinse and dry.

To produce the yellow shade which is in such demand give them a bath with a little picric acid, soured with a little oil of vitriol, and let them dry on the block.

Black.

(For 11 lb. of hats.)

Copperas	2 lb. 3 oz.
Red argol	1 lb. 1½ oz.
Bluestone	17½ oz.

If possible steep the hats over night in an old black dye beck, and dye up the next morning in a fresh water with about 4 lb. 6 oz. good logwood and a little turmeric.

The hats thus dyed appear at first rather brownish, but they assume a fine black luster on brushing.

Iron Gray.

(For 11 lb. of hats.)

Steep in a decoction of sumac, and dye cold in a beck made up with benzoline and a little acetic acid. There are three sorts of benzoline, so that the tone of the gray may be varied at will. These benzoline grays are much brighter than those obtained with the old processes.

Catechu Brown.

(For 11 lb. of hats.)

Boil with

Sulphate of alumina	17½ oz.
Bisulphate of soda	8¾ oz.
Oil of vitriol	4⅓ oz.

Add to the bath orchil, indigo, carmine, and turmeric, according to shade, and boil.—*Teinturier Pratique.*

PRACTICAL RECEIPTS.

Steam Black.

Extract of logwood at 30° Tw.	3 lb.
Red liquor at 14° Tw	1¾ lb.
Acetic acid at 8° Tw	1¾ lb.
Black liquor at 20° Tw.	3½ lb.
Oil	4¾ oz.

Boil with 1¾ lb. starch and stir till cold.

Dark Blue on Woolen Rep (22 lb.).

Dye at a boil with

Alum	17 oz.
Argol	7 oz.

and the necessary quantity of extract of indigo. When the shade is almost reached top with a little orchil liquor and a few drops of sulphuric acid.

Rose on Bleached Jute Yarn.

Mordant at 122° F. in red liquor at 8° Tw., and dye in a fresh water with saffranine at the same heat.

Blue on Bleached Jute Yarn (110 lb.).

To a warm water at 104° F., add:

Alum	17½ oz.
Soda	3½ oz.
Tartar emetic	1¾ oz.

Dye with methyl-blue, soluble in water (Baden Aniline Company), using more or less according to shade.

Buff on Cotton Yarn (31 lb.).

Annatto	2 oz.
Soda-ash	4 oz.

Dissolve in water at a hand heat. Give the yarns five turns and wring. Enter in a fresh lukewarm water, slightly soured with vitriol. Five turns. Wash.

Gray on Cotton Yarn (31 lb.).

Boil out 30 oz. fustic. Enter the yarn at a hand heat, and let soak for 15 minutes; sadden with the same weight of copperas, wash well and wring. Enter in a cold water with 60 oz. alum, and dye up to shade with a little induline.—(Williams Bros and Ekin.)

Scarlet on Cotton (22 lb.).

Dissolve in hot water separately 8¾ oz. good glue, and 17½ oz. curd soap; mix, enter the yarns, work well for half an hour, and wring out. Then enter the yarns in tin composition at 6¾° Tw., work well for half an hour, and wring. Enter into red liquor at 6¾° Tw., work for two hours and wring. Then dye at a hand heat in a water to which dissolved aniline scarlet is gradually added. As soon as the shade is reached the heat is raised a little, and the yarn is then let gradually cool in the flot.

The red liquor used in this process is prepared by dissolving 10 lb. alum and 10 lb. sugar of lead, each separately, mixing the solutions, letting settle, decanting off the clear liquid, and adding to it the solution of 2 lb. soda crystals.

Reddish Brown (22 lb. wool).

Sulphate of zinc	17½ oz.
Oil of vitriol	20¾ oz.
Fast brown (Gutbier and Götze's)	4 lb. 6 oz.
Acid magenta	8¾ oz.

This red brown is quite fast, and may be converted into a good black by means of logwood and soda.

Dark Brown on Felt (35 lb.).

Chromate of potash	17½ oz.
Oil of vitriol	3½ lb.

Boil for 30 minutes and add

Extract of logwood	4 lb. 6 oz.
G. and G.'s brown	8¾ lb.

Boil for one hour, lift, and air.—*Muster Zeitung fur Faerberei.*

NEW PROCESS FOR THE EXTRACTION OF THE IODINE CONTAINED IN SEAWEEDS.

By MM. Laurot and Collet.

This invention has for its object to extract the iodine contained in seaweeds, of what kind soever, without the destruction of the organic matter, and, consequently, permitting the residues to be used as manure.

The first operation depends on the action exerted upon the seaweeds containing iodine by the following bodies, with the aid of heat: Muriatic, sulphuric, and phosphoric acids, bisulphates of soda and potash, concentrated, but in small proportions.

The weeds are placed in cisterns of wood or iron, lined with lead, arranged so that they may be heated either by means of steam jackets or by steam pipes.

The mass is then sprinkled with one of the liquids above mentioned, in proportions which may vary from one to five per cent., according to the nature of the weeds operated upon.

There is formed at the bottom of the cistern a layer of liquid, and heat is applied to bring the whole to a boil. After a short time the whole forms a broth, consisting of a clear liquid and a finely-divided pulp, which is easily removed from the liquid by means of a centrifugal or a filter press.

The liquid thus obtained represents almost the whole of the moisture, the iodine, and the soluble matter contained in the weeds submitted to the operation.

This liquid is allowed to deposit the solid matters which it may hold in suspension, and it is evaporated down to half its bulk in a closed boiler, the steam which it gives off serving to heat another lot.

When it has been brought to this condition the liquid is transferred into appropriate vessels and mixed with perchloride of iron, nitrous sulphuric acid, manganese, or any other chemical reagent capable of setting at liberty the combined iodine. The whole is then made to boil, when the vapors of water carry away the iodine which is condensed and collected.

The acid liquid remaining behind is mixed with phosphate of lime in sufficient quantity to render the phosphoric acid soluble or assimilable, and the whole is then dried.

The composition of this product is varied according to the acid liquid employed to act upon the weeds.—*Moniteur des Produits Chimiques.*

CLASPS AS FASTENINGS FOR ARTIFICIAL DENTURES.

By J. W. Clowes, D.D.S., New York.

Than these, no items of professional practice have received more of my attention, and I am convinced, by long experience, of their entire reliability. Their sphere of usefulness, confined as they are to partial sets, is limited. Having a reputation as harm-doers in the past, I must needs be cautious in disclosing their excellence. To this end, the thing to be fastened as well as its fastening must be discussed, for a well-fitting plate and clasp must ever be united to attain success. In my practice, narrow but doubled gold plates are used, composed of what may be called the base and stiffener. I employ two castings and two counters. The base and stiffener are separately struck up and swaged. They are placed together and swaged again. Joined by a fine solder, they are again swaged, and all this between the same casting and its counter. Annealing should always precede swaging. Having advanced thus far by means explained, I now bring forth my reserved casting, and make the impress of the unchanged form upon my plate. My attention is next given to the fitting of clasps. Several important points are to be considered in this connection—a good hold is to be gained, damage to the natural teeth avoided, and ease secured in applying, wearing, and removing the plate. These requisites are absent while the natural teeth retain their original form.

If the clasps surrrounding the teeth merely touch the center of protuberance, the hold is slight and unstable, while the liability to injure is greatly increased by retention of extraneous deposits. Hence is shown the necessity for plain surfaces in the application of clasps. Approximal sides of all teeth which I intend to clasp are carefully and skillfully flattened with the file. Toughness and elasticity are essential qualities of a good clasp, and they are obtained by the alloyment, in due proportion, of gold and platinum. When about to fit clasps, I take the measure of the parts to be clasped with a piece of sheet lead. This pattern enables me to approximate pretty nearly to the length and width which I desire, and prevents waste of material. The gold, having been cut according to its pattern, is rounded and smoothed on its edges, and, when annealed, is ready to be bent and shaped for use.

My clasp-fitting is done entirely with pliers upon the teeth as they stand in the mouth, and my reliance is never upon any form of them which may be gained by impression in plaster or wax.

The part of a clasp first to be fitted should turn the posterior buccal corner of the tooth, passing along its approximal and flattened side to wind around its lingual swell, thence straight across its anterior face to a point just short of ocular perception. The turn at the place of beginning should be long enough to embrace the corner and enable the patient, by catching it with his finger-nail, to remove the plate from the mouth. Clasps should never be allowed to irritate and inflame the gums.

Having adjusted the plate to the gums and the clasp to the teeth, our next effort must be to connect them. If we succeed in this without in any way impairing the excellence of the work already accomplished, we may indeed rejoice. The plate fits, and the clasps fit, but the momentous question is, will they fit when united? I have seen the day when to be able, confidently, to say yes to this would have been manna to my soul! Groping in darkness, attended by defeat, is hard upon the constitution, and, looking back to my early days of professional trial, I confess to have often endured the rack from this very inability to make two things fit when together just as well as when apart.

With the plate and clasp in position, we proceed to take a try-plate impression. This may be obtained in plaster or wax. I prefer wax. For this purpose, if I have taken the original impression in wax, it is preserved in the pan until needed. This impression should be softened with warm water, retaining a sufficiency thereof in the clasp-teeth walls to render them softer than the rest. Now insert the plastic wax; with the thumb and two fingers of each hand apply it steady, now; exert no undue pressure on any one part, but firmly and evenly do the work. Withdraw it carefully and without rocking. You have it now—a try-plate impression—the very key, if you know how to use it, to ultimate success.

With the impression in your hand, what next? Remove the plate and clasps from the mouth, and restore them to their impressions in the wax—but, softly—the clasps first, and after them the plate. But—softly, again—you must not attempt to replace the clasps in the wax until you have expanded them with the pliers to an easy fit upon the teeth—a fit so easy that you may put on and take off, and feel that it is without stricture and without friction. With delicate tweezers lay them now, gently, in their waxy beds. As they lie there, harmonious in relation, harmonious in place, you may well exclaim, beautiful! beautiful!! Having filled up your impression with sand, plaster, and asbestos, and given an hour for setting, fasten your plate and clasps together with hard solder, and try them in the mouth. If you have been faithful to my directions, you will know how much like true satisfaction a plate and clasps may be. With this achieved, pause not until the lost in nature is replaced by the restored in art, and the denture, once more complete, exists, a thing of use and beauty.—*Dental Cosmos.*

ON THE USE OF A NEW SILVER SALT IN THE TREATMENT OF ORGANIC NERVOUS DISEASE.

By Allan McLane Hamilton, M.D., one of the Consulting Physicians to the New York City Insane Asylums, and to the Hospital for Nervous Diseases, Blackwell's Island, N. Y.

I have no doubt my own disappointment in the use of various remedies recommended by different authorities for the treatment of organic nervous disease is shared by many who have given even the most promising a fair trial. Nitrate of silver, a drug with an ancient reputation, is one of the few not to be despised, for occasionally it proves of great service, but, as a rule, it is entirely inefficacious. We are, therefore, too apt, in a great majority of instances, to resort in a routine way to iodide of potassium, or mercurial treatment, with variable results.

About three years ago it occurred to me that the combination of phosphorus with silver might well be worth trying. I therefore, through the kindness of Dr. Doremus, of Buffalo, procured a sample of the tribasic phosphate of silver, a salt prepared in the following manner: Precipitate a solution of argentic nitrate with a solution of trisodic orthophosphate, wash with distilled water, and dry in the dark. The process may be expressed as follows: $3NO_3Ag + PO_4Na_3,12H_2O = Ag_3PO_4 + 3NaNO_3 + 12H_2O, Ag_3,PO_4$.

A second sample of the drug was made by Mr. Frazer, of Caswell, Hazard & Co., New York, according to the above formula. It was a heavy powder of a lemon-yellow color, and was slightly darkened by exposure to the light.

The tribasic phosphate of silver possesses advantages over the other silver salts which entitle it to a fair trial. I have given it for months in doses varying from one-third to half a grain without any skin discoloration whatever, and its administration is unattended by the gastric irritability that so often follows the use of either the nitrate of silver or the phosphide of zinc. At the same time its therapeutical effects are much more pronounced. It is best given with some such excipients as argol and glycerine, for vegetable substances tend to decomposition; and for this reason I have discarded the confection of roses as an element of the pill mass.

In the first edition of my work upon Nervous Diseases* I directed attention to the probable advantages of this drug, especially in sclerosis of the posterior columns. The experience of two years has convinced me that it is my duty to urge others to make use of the remedy. In two classes of cases it has proved to be of great value: 1. In those of more or less acute myelitis with disturbance of the bladder and rectum. Not only in such cases of transverse disease has there been a decided improvement in the matter of control over the functions of these organs, but there has been a decided gain in the muscular power. This has been conspicuous in a very remarkable case of chronic meningomyelitis seen in consultation with Dr. Todd, of Ridgefield, Conn. 2. In cases of sclerosis of the nervous substance. In seven cases of posterior spinal sclerosis there has been a subsidence more or less in the violence of the pains, and in those who have taken the drug for over a year the power of locomotion is materially increased.

In six cases of inveterate epilepsy, as the result of gross inflammatory intracranial changes, the patients have been relieved, judging from the diminution in the number of the attacks.

I am now giving the drug to patients with cerebral tumor and general paralysis, and while it would be out of the question to expect anything like permanent cure in such hopeless diseases, I do believe that a persistent and proper use of the silver salt will do much more for the patients than any of the drugs hitherto used. I can find in medical literature no record of the use of the phosphate of silver, nor am I able to learn by inquiry that it was used prior to 1878. I sincerely hope that others may be prompted to publish their experience.—*Lancet.*

* "Nervous Diseases: their Description," etc.

THE MATERIALISTIC ORIGIN OF THE SEXES.

To the Editor of the Scientific American:

Mr. Dewar, in his paper on "The Materialistic Origin of the Sexes" (SUPPLEMENT, No. 271, page 4318), remarks as follows:

"The object of this paper was to prove the materialistic origin of the sexes—that sex had its origin in matter. That matter is dual is part confirmation of it, but, like its antitype, we must also prove dual matter to be productive. Two females will not produce, neither will two males. *If a production can be formed from the non-metallic elements only, or metallic only, then our theory is false.* Production should only ensue from the connection or interaction of opposite sexes and elements. Chemical analysis in this particular shows that we are right. No natural production can be found containing the elements of only one class; both metallic and non-metallic are essential to a formation."

I bear no malice toward materialistic ideas, but, on reading the above, a large number of compounds immediately presented themselves to my mind, which, taking Mr. D. at his word, prove that his theory is false.

Sulphur, oxygen, nitrogen, chlorine, phosphorus, and carbon, as examples, are always known as non-metallic. A few of their compounds, which are known to everybody, prove that "our theory is false:" SO_2, SO_3, N_2O_3, N_2O, NO_2, P_2O_3, P_2O_5, PCl_3, PCl_5, CO, CO_2, CS_2, etc., can, with one or two exceptions, in the case of nitrogen, perhaps, be formed by direct combination of the elements with each other.

If arsenic is a metal, we have the compound arsenide of tin, Sn_3As_2. We have, regarding hydrogen as a metal in the same sense as Mr. D., hydric arsenide, H_3As.

If arsenic should be called a non-metal, then there is a large number of compounds to add to our first list of examples.

"Materialism is yet in its infancy." Does it not look as if it would stay there if it has to found its growth on theories and lines of argument such as Mr. D.'s? Perhaps, as it grows older(?), it will know better than to call air "a dual combination . . . composed of oxygen, nitrogen, carbonic acid gas, hydrogen," etc. Perhaps it will learn a difference between chemical combinations, as water, carbonic acid, etc., and mechanical mixtures, as air.

DAVID WESSON.

Brookline, Mass., March, 1881.

CISTERN WATER.*

To most persons the type of good drinking water and of water good for culinary purposes, is that which falls upon the roof from the clouds in the form of rain or snow, and which is collected in lime-cemented cisterns under ground.

Each of the specimens was collected from an underground cistern, cemented with lime, and filled from the roof of a dwelling house.

Except No. 5, each was tinged with the color of soot, and No. 4 contained a remarkable amount of this substance.

All were neutral to sensitive litmus paper, and all when cold were without odor.

Cistern No. 1 was eight feet from a privy vault, filled with fecal matter to the surface of the earth. The surface of the water in the cistern was about four feet below the surface of the ground. The water was viscid, tinged with soot, and yellowish by transmitted light. The premises about the cistern were tidy. Persons drinking the water freely were not sick, but at the same time did not have the appearance of persons in good condition.

No. 2 was about eight feet from the vault described under No. 1, and about twelve feet from the vault on the adjoining premises. Its water was yellowish-brown by transmitted light, and somewhat viscous. The surface of the ground about the cistern was in a very untidy condition. Of the parties who had been drinking the water, one was sick with typhoid fever, and the others were looking badly.

Cistern No. 3 was also eight feet from a privy vault, and was described by the sanitary policeman who collected the water as in the same general condition as cistern No. 1.

Cistern No. 4 was fed from the shingle roof of a country dwelling. It was surrounded by deep gravel drainage, and at a distance from any surface sources of contamination. It was thoroughly aerated and in constant use. It had been cleaned within the year. Its waters were analyzed to furnish a standard of comparison for the others.

Cistern No. 5 contains five hundred barrels of water. It is on a gravel terrace sixty feet deep, and is in a condition which excludes the possibility of contamination by sewage, unless it be by back flow of the waste pipe from an inside water closet. Its water was collected in the expectation of finding the best possible specimen of cistern water.

After the analysis, it was found to have been twelve years without cleaning. It had been kept closed during that time, the water being drawn from it by a pump.

I also found that it swarms with water beetles.

The people drinking it were subject to malarial fever more than their neighbors.

The following scale, for the interpretation of the numbers under ammonia, is partly taken from the analysis of known waters, and partly from published tables.

SCALE FOR AMMONIA

Less than 0·0100,	superior drinking water.	
0·0100 to 0·0150,	good	" "
0·0150 to 0·0200,	not good	" "
0·0200 to 0·0250,	bad	" "
More than 0·0250,	very bad	" "

TABLE OF ANALYSIS OF CISTERN WATER.

1880. Date.	1880. Analyst.	LOCALITY.	Free ammonia.	Albuminoid ammonia.	Inorganic solids.	Organic and volatile solids.	Total solids.	Chlorine.	Hardness.
Sept. 30	Stuntz.	No. 1, Walnut Hills......	0·0041	0·1234	1·52	1·16	2·68	0·55	7·41
"	"	No. 2, Walnut Hills......	0·2745	0·0555	3·12	1·60	4·72	2·76	6·40
Nov. 3	"	No. 3, Walnut Hills......	0·0207	0·1177	2·72	1·76	4·48	1·97	8·39
Dec. 24	"	No. 4, Country..........	0·0038	0·0159	4·64	3·32	7·96	Trace 000	4·34
"	"	No. 5, Country.	0·0202	0·3600	2·28	1·82	4·10	Trace 000	2·76
Sept. 25	"	Eggleston Ave. Sewer ...	0·0546	0·0529	8·32	4	12·32	1·87	12·85
Dec. 2	"	Eggleston Ave. Sewer ..	0·2000	0·2148	19·05	6·16	25·21	7·48	7·10

On theoretical grounds, in which are considered the formation of snow and rain by condensation of moisture from the clouds, neglecting the sources of contamination, water collecting from the roofs should compare favorably with the chemically pure distilled water of the laboratory. The high estimation in which cistern water is held generally is probably caused by the theory of its pure source.

But it must not be forgotten that the atmosphere near the surface of the earth is pervaded with soluble gases through which the rain and snow must fall, and that the roofs of habitable dwellings upon which they are collected are perforated with chimneys, which vomit into the air constantly the gases, smoke, soot, and dust that are carried up from the fires and living occupants below.

Many houses, in addition to the chimneys, have ventilating pipes to living rooms, heated by indirect radiation, pipes to drains leading to sewers, and the waste pipe itself of the inside improved water closet, piercing the roof, and each contributing to load the air above it with fetid gases and deleterious solids carried up by the draught.

The atmosphere abounds in organic dust so light as to be carried on its currents, and in organic germs which await the stimulating action of water, and of heat, to produce in them corruptive decomposition, or to cause them to spring into deleterious life. This infectious matter is collected on the roofs, by the lateral currents to the ascending columns of warm air from the chimneys and ventilating pipes, and is washed bodily into the cisterns below.

On these other theoretical considerations, it becomes a question as to what rank the contents of the house cistern should hold among potable waters.

Dr. Frankland ranks it "suspicious water." Dr. Herman Hager says, "Rain water, when entirely pure, is drinkable, but not good drinking water. Cold snow water is unhealthy."

The examinations of cistern water have not, to my knowledge, furnished the facts from which can be determined the character of a given specimen, or on which the analyst can either authoritatively commend or condemn it. He has either to be guided by the general principles of water analysis, or to compare the results from examinations of suspected waters with those obtained from water known to be good.

The above table contains the numerical results of some analyses made at the order of the health officer of Cincinnati.

DEDUCTIONS.

1. The total solids of cistern water should not exceed four to five parts by weight in 100,000 parts by weight of water.

2. The hardness in grains per gallon should correspond closely to the amount of inorganic solids.

3. Chlorine, beyond the merest trace unless explained, should be taken as an indication of the presence of excrement of animals.

OBSERVATIONS.

1. Cisterns Nos. 1, 2, and 3 are evidently contaminated with human excrement. It will be noted that their hardness is excessive, in proportion to the inorganic solids.

Cistern No. 2 would seem to justify the inference that bad water becomes an active agent of disease, when thrown into active decomposition by the introduction of foreign materials.

The decomposing agents were probably introduced with the filth which abounded at the surface of the ground about the cistern curb.

Cisterns Nos. 1 and 3 were probably kept from fermentation and from being positive agents of disease, by the care of good housewives, who kept the premises neat.

Cistern No. 5, from the ammonia determination, ranks with Nos. 1 and 3, but the absence of chlorine excludes the idea of excrement. It is believed to have become foul entirely from organic matter in a fine state, which was drawn to the roof by lateral currents to the chimneys, washed down from the roof, and collected at the bottom of water not sufficient aerated to cause its full decomposition. It will be noted that its total solids in solution fall low.

The water of Eggleston Avenue sewer, here given probably at its best and worst, was analyzed to give a standard of comparison, as to presence of impurity.

The Sanitary Committee of Cincinnati suggest that a few rules in the management of cisterns are to be derived from the above report:

1. Cisterns should be repeatedly and thoroughly cleansed, and especially those receiving water from roofs of dwellings.

2. The drainage *away* from the cistern should be perfect.

3. The cistern should be located as far from the privy vault as possible, and care should be taken that the matter in the privy vaults be kept constantly below the level of the bottom of the cistern.

4. Cistern water should be drawn by means of buckets, chain pumps, or such other means as will introduce plenty of fresh air into the water.

* A report, January 10, 1881, of analyses of cistern water, to determine the presence of sewage and other impurities. By C. R. Stuntz, A.M., M.D., Professor of Chemistry, Cincinnati, O. Made by order of the Board of Health, Cincinnati, O., A. J. Miles, M.D., Health Officer.

ASCENT OF CHIMBORAZO AND COTOPAXI.*

By EDWARD WHYMPER.

I HAVE been invited by the Society of Arts to deliver a lecture to you upon a journey which I recently made to the great Andes of the Equator. Some of you may perhaps think it strange that anything connected with mountain travel or mountaineering should be brought before you; but if you consider for a moment you will at once perceive that the art of mountaineering is a high art, and is, therefore, worthy of being encouraged by the society. Up to this time most of the loftiest portions of the earth are totally unexplored, and this arises principally from the fact that the mountaineer, in addition to experiencing most of the troubles which are met with by other travelers, has to deal with some which are peculiar to his work. I do not now refer to the distressing hemorrhages, alarming vomitings, and painful excoriations which are said to affect him. Hemorrhages and excoriations are rather alarming words, so long as they remain untranslated into ordinary language; but they do not seem to be so very formidable if they are called bleeding at the nose and loss of skin through sunburn; and it may also somewhat tend to allay alarm, if I say that I have never known cases of bleeding at the nose occur in mountain travel except to those who are subject to the complaint; while, with regard to vomiting, it has only been known to occur to persons who had taken something to disagree with them. But there is another trouble, which cannot be dismissed so lightly. All travelers, without exception, who have ever attained great altitudes, have spoken of having been affected by another complaint, and this complaint is known to affect even natives of those regions, and persons who have lived in them, as well as casual travelers. This is usually called mountain sickness. There have been numerous conjectures put forward as to its cause; very often it has been supposed to be the work of mysterious spirits, sometimes it has been attributed to weakness, and other causes, but there can be very little doubt that it arises simply from the diminution of atmospheric pressure as one goes upward. At 20,000 feet the pressure is less than half the amount that it is at the level of the sea—that is to say, whereas at the level of the sea the atmospheric pressure is generally capable of sustaining a column of mercury at 30 inches, at 20,000 feet it will not sustain a column of 15 inches. Now, those of you who have witnessed experiments with the air pump must know that remarkable effects can be produced by reducing the pressure of air. I well remember the first occasion on which, when at school, I saw an old and shriveled apple placed beneath the air receiver, and I watched with glee its wrinkles disappear gradually under a diminished pressure, and the apple fill out again, until at length it became as plump as it was in the days of its youth. The effect I then witnessed struck me as so remarkable that I at once determined to see if I could not recommend its further application, and, on my return home, I suggested that the appearance of my grandfather would be greatly improved if he could be put under the air pump; but as this application of science to my progenitor caused an application of something else to me, I have ever since regarded myself, in a small way, as a martyr to science. From seeing air-pump experiments, and other purely philosophic considerations, it is obvious that the human system must be liable to derangement, if subjected to sudden diminution of the atmospheric pressure to which it has been accustomed. These depressions have often been so severe as to render mountain travelers incapable, and their lives well nigh unendurable, so it is scarcely to be wondered at that they have endeavored to escape from the infliction by descending into lower regions. I do not know of a single instance of a traveler who, having been afflicted in this way, has deliberately, so to speak, sat it out, and had a pitched battle with the enemy. Nor am I aware that any one has ever suggested the bare possibility of coming out victorious from such an encounter. Yet upon doing so depended the chance of pushing explorations into the highest regions of the earth, and I long felt a keen desire to know whether my own organization at least could not accommodate itself to the altered conditions. From considerations which would occupy too long to enter into now, I gradually acquired the conviction that patience and perseverance were the principal requisites for success, and the journey of which I am now going to speak was undertaken with the view of bringing this matter, among other things, to a definite issue. In the course of it we camped out at very great heights, twenty-one nights were spent above 14,000 feet above the level of the sea; eight more above 15,000 feet; thirteen more above 16,000 feet; six more above 17,000 feet; and one more at 19,000 feet. I shall not now anticipate what you will presently hear, but I have made these preliminary observations to render less frequent interruptions of the narrative, and for the purpose of explaining allusions in it which might otherwise perhaps have been only half understood.

Fifteen years ago, when my apprenticeship to the art of mountaineering was finished, and I cast my eye over the map of the world in search of new districts, it was not long before it was directed to the great Andes round about the Equator, they being, perhaps, the mountains of the most exalted reputation, and of great elevation, which still were little known. The highest of the group, Chimborazo, long accounted to be the loftiest mountain in the world, had received the attention of travelers of great celebrity, and in recent years its ascent had been essayed by French, Germans, Americans, and Ecuadorians. All had failed, and each succeeding failure increased the desire I felt to annex it to my own country. To-night I shall speak to you of Chimborazo and Cotopaxi alone, and I select these two mountains on account of the contrast which they afford. The one is capped by eternal snow, and the other burns with perpetual fire. Chimborazo is an extinct volcano, while Cotopaxi is an active one, and is, I believe, the loftiest volcano in working order.

I left Southampton for this journey on November 3, 1879, and arrived at Guayaquil on the 9th of the following month. At the time of my arrival this town was affected considerably by the war between Peru and Chili, and its inhabitants evinced the most impartial desire for the success of both sides. It has been described by previous travelers as a place where there is always something doing, either there is a revolution going on, or an earthquake, or a fire, and this description is fairly accurate; and when I tell you that assassinations were occurring in the streets every day, you will perceive that it is a place well suited to a person of adventurous temperament. Besides this, it may be mentioned that the rivers round about swarm with alligators, and the surrounding land with snakes, many of the most deadly kind. I was not in town during the wet season, but I am informed that at that time the river overflows the exterior land, and that

* A recent lecture before the Society of Arts, London.

the non-amphibious vermin in general climb posts and trees, and exhibit the most extraordinary spectacle. You see snakes hanging by the tail from rails, sitting on the top of posts, struggling and writhing in all kinds of inconceivable ways to escape from the deluge; while associated with them are scorpions and all kinds of strange creatures for which science has scarcely a name.

From Guayaquil we went by a river steamer to Bodegas, and at that place our journey may be said to commence. My party consisted of two Italian mountaineers (cousins), Jean Antoine and Louis Carrel, a Mr. Perrin, whom I had picked up at Guayaquil, to interpret, and a number of mules and muleteers. The road we followed was the grand route to Quito, and almost all the trade from the coast to the interior passes over. Its difficulties have been much exaggerated. It is a track, or series of tracks—generally very narrow, often very muddy; and there is a constant passage of mules, well laden with the most varied goods. Sometimes "Perrier Jouet" champagne is found assorted with iron bedsteads; then one sees sheets of corrugated iron laid flat across the backs of donkeys, or a grand piano carried on the heads of six or eight Indians. In the reverse direction you have droves of beasts, often twenty to thirty in a group, coming to the coast, bringing huge bales of quinine bark, accompanied by gangs of shambling Indians, who, for the most part, are very civil. The laborers generally have a good day or a good night for the traveler; but, in respect of the language they employ to their beasts, I can only say that, in comparison, the observations of an angry London cabman are decent, and those of a drunken bargeman are moral.

Three days' travel from Bodegas brought us to the town of Guaranda, and here I found a portion of my heavy baggage, which had been sent out some months in advance. This town is fifteen miles in a straight line from Chimborazo, which was the central point of the journey. Many of you were probably under the impression that Chimborazo is often seen from the Pacific. There is an eloquent passage in Prescott's "Conquest of Peru," describing the magnificent prospect which it affords to the mariner. The fact, however, is that it is very seldom seen from the ocean. Captains who go up and down the coast say that they do not see it more than three or four times in thirteen or fourteen years. And, when I tell you that it is distant ninety-one miles in a direct line from Guayaquil, and from that place is elevated less than 3° above the horizon, you can form your own idea as to its magnificence from the Pacific Ocean, which is sixty-six miles still farther away. Up to this time we had not seen Chimborazo at all. We started from Guaranda on December 19, still continuing the Quito road, and passed over the southern slopes of the mountain to see if we could commence to make out a route which should promise a chance of success. We came right on the mountain before we saw any part of it, and from that day the summit was always enveloped in clouds. It was obvious we could only go as far as we could see, so we returned to Guaranda to wait until the summit was clear. While returning I was overcome with dizziness, feverishness, and intense headache, and had to be supported by two of my people for the greater part of the way. Imagining I was attacked by fever, I took thirty grains of sulphate of quinine in the course of the night, and was covered up with mountains of blankets, but next morning there was nothing the matter. As the symptoms were those which occurred at a later period, when we were undoubtedly leaving the low atmospheric pressure, I ultimately concluded that it was through this that my indisposition was caused. On this point allow me to say a few words further with regard to the troubles which occur to persons who get to great altitudes. Although the heights of the Andes, which we were about to visit, had not been well determined, there was reason to believe that several of them approached, if they did not exceed, 20,000 feet. At the time of our departure there were only three tolerably well authenticated instances of persons having reached that height on land, and I could learn nothing which was of the least service respecting the experience of those who were engaged in those expeditions. But from others who had reached altitudes of from 17,000 to 18,000 feet, I heard a confirmation of my supposition that, at such great elevations, I ought not to expect a continuance of the immunity from mountain sickness which I had hitherto enjoyed. I made up my mind, therefore, before we left, that, sooner or later, we should suffer like the rest of the world; but, being of opinion, as I have already said, that patience would overcome mountain sickness, it was my intention, on all our expeditions, first to establish camps as high as we could force the natives and mules; and, as it would be impossible to retain the natives at those positions, it became necessary to provide ourselves with food sufficient for weeks, or even for months, so that, in the event of our failing in our enterprise, from badness of weather, mountain sickness, and other causes, we should not have the mortification of being obliged to abandon our positions simply from want of sustenance. And as it could not be expected that we should be able to obtain on the spot the provisions which would keep for such a length of time, I concluded that the only safe course was to make ourselves, from the first, entirely independent of the resources of the country, in the matter of the food which should be consumed at the greatest heights. About two tons weight of the most portable and most condensed provisions went out for our use, and, irrespective of the things which were bought already tinned, more than 2,000 tins were soldered down. If time would permit, it would be interesting to enter into details respecting our outfit, but I must do no more than say that our provisions were arranged in boxes weighing seventy-five pounds apiece. Two of them made a mule-load, and each of them held three tin cases, soldered down, each of those three tin cases containing food for four days for one man. They included everything necessary except water and fire. The preparation of these provisions and the rest of the outfit occupied almost as much time as the performance of the journey, and it appears to me desirable to say this much on the subject, lest any persons who should be tempted to follow in the track should be inclined to doubt our veracity, through finding it impossible to progress with reasonable rapidity. A great saving of time was effected by arranging the food in this manner, and if a small journey was made, which was calculated to occupy two men for four days, I had only to say take ten cases, instead of continually calculating, and then being afraid that candles, salt, or matches might be forgotten.

After two days more we saw the upper part of Chimborazo for the first time; it appeared to be fine, and so I sent off two guides to select a camping place on the ridge we had examined on the 19th, while I completed the preparations for the journey. They returned on the 23d, very much fatigued, having found a place which was suitable at a height, so it appeared afterward, of 16,500 feet above the sea. Then Christmas came in the way, and our start was delayed until the 26th, when we at length got off—a caravan of nineteen persons and fourteen mules. Shortly before our departure from the town I had the honor to receive a visit from the political authorities, and I did not at first perceive what was the object of the interview; but just before they left the principal official thus addressed me: "Senor, we understand perfectly that, in an affair like yours, it is necessary to dissemble a little, and you, doubtless, do perfectly right to say that you intend to ascend Chimborazo, a thing which everybody knows is impossible. We know perfectly well what is your object; you wish to discover treasure which is buried in Chimborazo, and, no doubt, there is much treasure buried there, and we hope you will discover it; but we also hope that when you have discovered it you will not forget us." "Gentlemen," I said, "I should be delighted to remember you, but in respect of the other matter, the treasure, I venture to suggest that you should pay half the expense of the expedition and take half the treasure we discover." But this idea was rather too speculative for them, and the interview produced no result.

On our way up we went over the Quito track, and then, leaving the road on our right, we bore away directly toward the mountain. Night set in just as we were fairly arrived at its foot, and we encamped at a height of 14,400 feet, having risen 5,500 feet in coming to Guaranda. During the night two Indians, who had been acting as porters, deserted, and five mules also ran away. Our carrying power being thus reduced, it was necessary to make two journeys from the first camping place on the ridge to a place very near the summit, S. W. by S., where the Carrels had selected a place for the second camp. Jean Antoine went away with the first detachment, and Louis and myself returned to fetch up the others. The rest of us then went up and arrived at about a quarter to five in the afternoon, having risen about 2,100 feet. We were now more than 16,500 feet high, and established ourselves there with provisions enough for three weeks and with fuel enough for several days. All water had to be obtained by melting snow, of which there was enough around about us, and to keep up our stock of fuel and communications with the world below, I retained a muleteer and one beast to go backward and forward between our camp and the nearest hovel.

All the rest of our troop now left us, and did so very gladly; for although we had succeeded in establishing our camp on the selected spot, it had only been done by the greatest exertions on the part of my people and their beasts. The mules were forced up the very last yard that they could go, and staggering under their burdens, which were scarcely more than half the weight they were accustomed to carry, stopped repeatedly, and, by their tremblings and falling on their knees and general behavior, showed that they had been driven to the very verge of exhaustion. When we arrived at the second camp we ourselves were in good condition, which was to be expected, as we had ridden up the entire distance from Guaranda; but within an hour I found myself lying on my back, along with both the Carrels, placed *hors de combat*, and incapable of making the least exertion. We knew that our enemy was upon us at last, and that we were experiencing our first attack of mountain sickness. We were feverish, had intense headaches, and were unable to satisfy our desire for air except by breathing with open mouths. This naturally parched the throat and produced a craving for drink, which we were unable to satisfy, partly from the difficulty of obtaining it and partly from the difficulty of swallowing it, for when we got enough we were unable to drink, we could only sip; and not to save our lives could we have taken a quarter of a pint at a draught. Before one-tenth of it was down we were obliged to stop for breath, and gasp again, until our throats were as dry as ever. Besides having our normal rate of breathing largely accelerated, we found it impossible to get along without every now and then giving a spasmodic gulp, just like fishes when taken out of the water. Of course there was no desire to eat, but we wished to smoke; and even our pipes almost refused to burn, for they, like ourselves, wanted more oxygen. This condition of affairs lasted all night and all the next day, and I then managed to pluck up spirit enough to get out the chlorate of potash, which, by the advice of Dr. Marcet, I had brought in case of need. Chlorate of potash was, I believe, first used in mountain travel by Dr. Henderson in the Cara range, and it was subsequently ordered by Sir Douglas Forsyth in his mission to Yarkand in 1873-4. The surgeon to the expedition states that he distributed little bottles of it among the members of the embassy, and says that, from his own experience, he can testify to its value in mitigating the distressing symptoms produced by a continued deprivation of the natural quantity of oxygen in the atmosphere. Before my departure Dr. Marcet urged me to experiment with a view to confirming this experience; ten grains to a wine glass of water was the dose recommended, to be repeated every two or three hours if necessary. I say distinctly that I thought it was of use, though it must be admitted it was not easy to determine, as one might have recovered just as well without taking any at all. Anyhow, after taking it, the intensity of the symptoms diminished; there were fewer gaspings, and in time a feeling of relief. I am so far in favor of its use that I should always carry it on future expeditions. Louis Carrel also submitted himself to the experiment, and seemed to derive benefit, but Jean Antoine, the elder of the two, sturdily refused to take any doctor's stuff, which he regards as an insult to intelligence. For all human ills, for every complaint, from dysentery to want of air, there was, in his opinion, but one remedy, and that was wine; most efficacious always if taken hot, more especially if a little spice and sugar were added to it. His opinions on things in general were often very original, and I learned much while in his company; among other things, that for the cure of headache, nothing better can be mentioned than keeping the head warm and the feet cold. I am bound to say he practiced what he preached, and I can remember no more curious sight than of this middle-aged man, lying nearly obscured under a pile of ponchos, with his head bound up in a wonderful arrangement of handkerchiefs, vainly attempting to smoke a short pipe, while gasping like a asphyxiated codfish, his naked feet sticking out from underneath the blankets, when the temperature in the tent was much below the freezing point.

It seems curious to relate that Mr. Perrin did not appear to suffer at all, and except for him we should have fared somewhat badly. He kept the fire going—no easy task, for the fire appeared to suffer for want of oxygen just like ourselves, and it required such incessant blowing that I shall consider for the future a pair of bellows an indispensable part of a mountaineer's equipment. Mr. Perrin behaved on Chimborazo in an exemplary manner—he melted the snow, brought us drink, and attended to our wants in general; it goes, therefore, somewhat against the grain to say that he was in very poor health in consequence of having led rather a dissipated life; in fact, he was so far debilitated that he could not walk a quarter of a mile on a flat road without desiring to sit down, or one hundred yards on a mountain side without being obliged to rest. Had I been aware of his previous history he certainly should not have accompanied us. You will naturally inquire—How can you account for this man, with his shattered constitution, who also was no mountaineer, being unaffected, when three others, who were all more or less accustomed to high ascents, were, for a time, completely incapable? The explanation appears to be this: Perrin had been for a long time resident in Ecuador, at heights of from 9,000 to 10,000 feet, and had several times passed backward and forward over a height of over 14,000 feet. The mean elevation at which he had resided during the last ten years was, in all probability, much higher than the mean elevation at which we others had lived, and it would probably have been found, had he been subjected to examination, that his manner of respiration, and even his organs, had become better adapted to a pressure of 18½ inches, which was the height of the mercurial column at our second camp.

On December 29 the Carrels were somewhat better, and were eager to be off exploring, so I sent them away to continue the ascent of the ridge on which our camp was placed. I instructed them not to go to any great height, and to look out for another and higher camping place. The rock of our ridge was trap—I have a sample of it here—it was shattered by frost, and everywhere in a state of ruin. Just above our tent it was easy enough to traverse a stony waste, mingled with patches of sand. Higher up it became precipitous, and, at about 17,000 feet, it was necessary to climb a little. Then its angle diminished, and there were large snow drifts on each side; still higher the crest of the ridge was composed of gravel and frozen ice. At 18,500 feet the ridge came to an end. It was crossed by some precipitous rocks, and, after passing these, you entered on the snow region which crowns the mountain on all sides. On the east of this ridge we had rather a considerable glacier, which was fed, if not entirely formed, by the ice which fell from above, and at its sides there were sheer cliffs, over which the glacier which caps the mountain was projected. The slices of glacier which fell from these cliffs tumbled over the precipices and the slopes at their base 3,000 feet before they were arrested by the glacier beneath, and in the course of falling brought away enormous fragments. The glacier was laden with smashed ice blocks and the rocky fragments which it brought down, and we accordingly called it the *glacier de débris*. These cliffs, and those which face W.N.W., are the most elevated and the greatest of Chimborazo, and they were quite sheer and inaccessible. They were composed of a number of well-marked strata, disposed with great regularity, and it was easy to identify the beds from which fragments had fallen on the glacier by the color alone. All were trap; some were vitreous; others stony, and they presented the widest variety of colors, from a delicate rose to a coarse red, and from pale gray to the black of the beds of scoriæ. The whole of the rocks, and I collected some thirty varieties, are distinctly volcanic, and the doubts which still seem to linger on this matter are now finally disposed of. The very highest rock I obtained from about 15,500 feet is an absolute cinder.

The Carrels returned soon after dusk, both extremely exhausted; they could scarcely keep on their legs, and threw themselves down and went to sleep without eating or drinking. Their condition, and the report I heard next day, rendered it certain that our second camp, as a starting place, was not placed high enough. It appeared that the Carrels, neglecting their instructions, had been toward the summit, and reached a height of only about 19,500 feet. They were quite unencumbered, carrying no instruments, and only enough food for their own use, and had no traveler to look after, and yet came back quite exhausted. It was obvious, therefore, we should have to get still higher up before we could make an exploration of the real summit. So soon as they were well enough I sent Louis down to the camp to fetch up the tent, which had been left there, and as soon as it arrived we were in a position to go forward again. On the following morning I went myself up the ridge to look for a higher camping place, and found one on the eastern side on some broken rocks, at a height of 17,400 feet. By this time I was in rather better condition than the Carrels; the feverishness had disappeared, and my blood had resumed its normal temperature. The gaspings had nearly ceased and the headache had gone. You will perhaps wonder how I knew I was feverish; for in regard to this matter one is often mistaken, and fever is supposed when it does not exist. By the advice of the distinguished physician whose name has been already mentioned, Dr. Marcet, I had provided myself with a registering clinical thermometer for the purpose of taking the blood temperature at great elevations. This was duly done, and, in respect of this matter, nothing more need be said than that at our greatest heights the temperature of the blood was just as it is at the level of the sea—higher during periods of warmth and lower when unusually cold. But still, at its normal height, when the thermometer is at 60° or thereabouts, it did not appear to be affected by a low atmospheric pressure at all. In recommending me to take this little instrument, of which I have one in my hand, Dr. Marcet rendered me a great service, and among all the devices and instruments which have been pressed upon the attention of travelers in general, of late years, I know nothing equal to it in importance. By constant observation I was able to detect the earliest advances of fever, and, by taking proper steps in time, I was able to get through the entire journey without having an attack of fever worth mentioning. Its expense is trifling, and it can easily be carried in the waistcoat pocket. When we were first laid on our backs by mountain sickness it showed that my blood temperature amounted to 100·4°, but by the end of the year it had fallen to its usual height, viz., 98°. Still, although the more disagreeable symptoms had gone, we found ourselves remaining comparatively lifeless and feeble, with a strong disposition to sit down when we ought to have been moving. There was plenty just about this time to keep us moving. First the muleteer, who was retained to keep up communication, came up and reported that some boxes left in depot at the first camp had been broken open and robbed. This involved going down to make an inspection and dispatching Perrin to Guaranda. Then we found a quantity of tinned meat had gone bad, and we had a world of trouble over it. I had invested in a quantity of ox-cheek, and one tin had been placed in each of our cases. Upon opening the first case I noticed that the end of the ox-cheek tin had bulged, and, knowing what that meant, I had it thrown away at once. One after another we found the same thing, and at once, on opening another, a most vile stench rushed out, and I found the ox-cheek had burst its bonds, and not only became putrid itself, but had corroded and ruined almost the whole of the food in the case. It then became necessary to

examine seriatim each case to know exactly how we were off for food, and the end of the matter was we found ourselves obliged to hurl over the cliffs provisions that had cost us, in round numbers, £100.

It would be merely wasting your time to recount the troubles we had in the wind, hail, snow, and thunderstorms—which we had night and day—from which we suffered, each and all. The snow fell occasionally as much as six inches at a time; it was always fine and granular and not in flakes. But we had far more hail than snow, and it fell continuously. Thunderstorms visited us with unvarying regularity every day. These occurrences delayed our progress, and it took three days to move the requisite quantity of material up to the third camp. At length, on the 2d January, last year, having passed the night at our highest station, leaving communication open in our rear, I conceived the time had arrived when we might prudently make for the summit, and on the following morning, at half-past five, the Carrels and I started, and mounted about 1,000 feet without any great difficulty. We had arrived at the rocks I have spoken of as crossing the ridge of the mountain. We were half way up this, when a furious and intensely cold wind arose, and we found ourselves compelled to abandon all the things we were carrying, and to fly for refuge to the camp, holding ourselves in readiness to start the next morning. This happened to be very fine and cloudless, and, profiting by the steps we had made the previous day, we mounted by a fair road, crossing these rocks and getting to a height of about 18,4 0 feet at eight o'clock. We then bore away to the left, that is to say, toward the west, over a snow-covered glacier, and ascended spirally, so as to break the ascent. There were few crevasses; the snow was in good order, although steps had to be cut in it. I noticed that our steps got shorter and shorter, until at last the toe of one foot touched the heel of the previous one. At 10 A.M., at a height of 19,500 feet, we passed the highest rock, which, I have already said, was nothing but a volcanic cinder. For some distance further we continued our progress at a reasonable rate, having fine weather and a good deal of sunshine. At about 11 A.M. we fancied we saw through the heavy clouds which covered the whole country to the west, and shortly afterward, being then nearly 20,000 feet high, we arrived at another plateau near the top of the mountain. The summits now seemed within our grasp; we could see both, one on our right and another a little further away on our left, with a hollow plateau about one-third of a mile across between them. We remarked that in about another hour we could get to the top of either, and, not knowing which of the two was the higher, we made for the nearer, but at this point the condition of affairs completely changed, the sky became clouded all over, wind arose, and we entered a large tract of dusty, soft snow, which could not be traversed in the ordinary way. The leading man was up to his neck, almost out of sight, and had to be pulled out by those behind. Imagining we had got into a labyrinth of crevasses, we turned about right and left to try and extricate ourselves, and, after discovering it was everywhere alike, we found the only possible way to proceed was to flog every yard of it down, and then crawl over it on all fours, and even then, one or another was frequently submerged, and almost disappeared. Needless to say, the time went rapidly. When we had been at this sort of work three hours, without having accomplished half the remaining distance, I halted the men, pointed out the gravity of the situation, and asked them whether they preferred to turn or go on. After consulting together, Jean Antoine said, "When you tell us to turn we will go back; until then we will go on." I said, "Go on," although by no means feeling sure it would not have been best to say "Go back." In another hour and a half we got to the foot of the southern summit, and, as the angle steepened, the snow became firmer again. We arrived at the top of it about a quarter to four in the afternoon, and then had the mortification of finding it was the lower of the two. There was no help for it, we had to descend to the plateau, resume flogging the road, and floundering on, to make for the highest point. There, again, when we got up to the dome, the snow was reasonably firm, and we arrived upon it at last, standing upright like men, instead of groveling, as we had been during the last five hours, like beasts of the field.

(*To be continued.*)

A LOST CITY.

GOUR, THE RUINED AND FORGOTTEN CAPITAL OF BENGAL.

AMONG the marked peculiarities of Anglo-Indians is one which we have never heard fully explained. As a rule they know nothing about India. They are not interested in it, and do not study it, do not take even the trouble to see the wonderful things of which the country is full. We should like to know how many Anglo-Bengalees know anything of the marvelous city of which the name stands at the head of this article; Gour, the ruined capital of Bengal, the Ganga Regia of Ptolemy, where Hindoo kings are believed to have reigned two thousand years ago, where semi-dependent Mussulman rulers undoubtedly governed Bengal before Richard Cœur de Lion died, and where Kai Kaus Shah, 1291, founded a sovereignty, which, under the different dynasties, one of them Abyssian, endured to 1537. These kings made Gour, by degrees, one of the greatest cities in the world—greater, as far as mere size is concerned, than Babylon or London. Mr. Ravenshaw, a civilian, who took photographs of every building he could reach, photographs published since his death, believes the ruins to cover a space from fifteen to twenty miles along the old bed of the river, by three miles in depth, a space, which, after allowing for the rich native method of life, with its endless gardens and necessity for trees, must have sheltered a population of at least two millions. These kings must have been among the richest monarchs of their time, for they ruled the rice garden of the world, Eastern Bengal, where rice yields to the cultivator 160 per cent.; they controlled the navigation of the Ganges, and their dominion stretched down to the Orissa, where the native princes—how strange it sounds now, when Orissa is a province forgotten, except for an awful famine!—were always defeating their troops. They spent their wealth necessarily mainly on a mercenary army, often in revolt, for their Bengalees could not fight the stalwart peasants who entered the army of the kings of Behar, and their fleet could not always protect the weak side of the capital; but they covered the city with great structures, opened "broad, straight streets, lined with trees," and built inner and outer embankments of this kind:

"The boundary embankments still exist; they are works of vast labor, and were, on the average, about forty feet in height, being from 180 to 200 feet thick at the base. The facing throughout was of masonry, and numerous buildings and edifices appear to have crowned their summits; but the whole of the masonry has now disappeared, and the embankments are overgrown with a dense jungle, impenetrable to man, and affording a safe retreat for various beasts of prey. The eastern embankment was double, a deep moat, about 150 yds. wide, separating the two lines. A main road ran north and south through the city, its course being still traceable by the remains of bridges and viaducts. The western face of the city is now open, and probably always was so, having been well protected by the Ganges, which, as has already been observed, ran under its walls. In the center of the north and south embankments are openings, showing that these fortifications have been perforated to afford ingress to and egress from the city. At the northern entrance there are no remains, but at the southern still stands the Kutwali gate, a beautiful ruin, measuring fifty-one feet in height, under the archway. Within the space inclosed by these embankments and the river stood the city of Gour proper, and in the southern corner was situated the fort, containing the palace, of which it is deeply to be regretted that so little is left. Early in the present century there was much to be found here worthy of note, including many elegantly carved marbles; but these are said to have become the prey of the Calcutta undertakers and others, for monumental purposes. On the roadside, between the palace and the Bhagirathi River, there now lies, split in twain, a vast block of hornblende, which, having been carried thus far, has been dropped and left as broken on the highway, to bear its testimony against the spoilers. Surrounding the palace is an inner embankment of similar construction to that which surrounds the city, and even more overgrown with jungle. A deep moat protects it on the outside. Radiating north, south, and east from the city, other embankments are to be traced, running through the suburbs, and extending in certain directions for thirty or forty miles. These include the great causeways or main roads leading to the city, which were constructed by Sultan Ghivasuddin. The greater part of them were metaled, and here and there they are still used as roads, but most of them are, like those within the city, overgrown with thick jungle."

Within the embankment, ten miles by three, the kings constructed splendid mosques by the dozens; palaces, public buildings, deep and huge reservoirs, and so many houses that, after three centuries of spoliation, "there is not a village, scarcely a house in the district of Maldah (which is as big as an English county), or in the surrounding country, that does not bear evidence of having been partially constructed from its ruins. The cities of Murshidabad, Maldah, Rajamahal, and Rangpur have almost entirely been built of materials obtained from Gour, and even its few remaining edifices are being daily despoiled." The kings built in brick and stone, and used for many mosques a material which Mr. Ravenshaw calls marble, but is more like what a hard freestone would be if it could be a deep coal black. The quarries from which the material was obtained are still, as far as we know, uncertain; but it must have existed in enormous quantities; it took the chisel perfectly, and it appears inaccessible, even in that destructive climate, to the effect of time. We have seen a mantelpiece of it, engraved with the Mohammedan profession of faith, known to be eight hundred years old, and the letters, cut to the depth of a line, are as clear as if the work had been done yesterday. The Gour architects built splendid Saracenic arches, gateways, and domes, and spared no expense or time on elaborate decoration, in a style which deserves separate study, for it marks the deep influence of Hindoo antiquities on men who were recently Mussulmans, and probably Moors from Spain. There is evidence that the grandeur and luxury of the city made a deep impression on Asia, for in one or two of the later Arabian stories it is treated as country folk treat London; while its civilization and polish so impressed the people that to this hour a Bengalee Pundit, desirous of describing and honoring his native tongue, calls it not Bengalee, but *Goureye bhasha*, "The tongue of Gour," just as a Frenchman says, "That is Parisian."

And then, as it were in a day, the city died. The native tradition is that it was struck by the wrath of the gods, in the form of an epidemic, which slew the whole population; but it is more reasonable to believe, with Mr. Ravenshaw, that the epidemic, probably akin to cholera, finished a ruin partly accomplished by war and by the recession of the Ganges, which, after cutting its way into a channel four miles off, is now slowly cutting its way back again.—*London Spectator.*

THE STONE STATUES OF THE ILE DE PAQUES.

THE Ile de Pâques, the most easterly of the Southern Sporades, in the Pacific Ocean, is of a volcanic nature. It is quite an extensive strip of land, triangular in shape, and having an area of from about 27,000 to 29,000 acres. At each of its three angles there is a large crater at the summit of a high conical elevation—*Rana Aroï* at the north, *Rana Ranaku* at the east, and *Rana Kau* at the west. Its surface, although as a general thing flat or slightly undulating, is here and there dotted with peaks and volcanic elevations like those above-mentioned, and among which that of *Tautapu*, in the center of the island, is remarkable for the great regularity of its form. Although often visited since its discovery, by the Dutch Admiral Roggewen, in 1722, we possess as yet no information as to the nature and products of its volcanoes, which have sometimes been stated to be of a basaltic and at others of a trachytic nature. All navigators who have landed there have been struck with the mournful and desolate aspect of this islet, lost in the midst of the great Pacific; and all have mentioned the presence on its surface of a large number of remarkable colossal human faces carved out of entire blocks of volcanic rock. These heavy and massive hewn stones represent gigantic busts of a mean height of 20 to 23 feet by about 7 feet in width. More than four hundred of them have been counted, many of them being as much as 39 feet in height; and some, now broken, must have been of still more colossal dimensions. They all bear a close resemblance to one another, and appear to have been sculptured after the same model and by the same hand; although the latter theory is inadmissible, for the lifetime of one man would not have sufficed to execute two or three of the largest. These monuments, which are witnesses of a powerful population now passed away, and of which the unfortunate race now inhabiting the isle can give us no idea and has preserved no tradition, are well worthy of fixing our attention. All those who have examined them have pondered especially over the mechanical means that must have been employed to transport such large masses to the places that they now occupy.

In spite of all researches these monstrous idols (?) are still an enigma. One of these statues was transported to France in 1872, by Admiral De Lapelin, and presented to the Museum of Natural History at Paris. In 1877 a traveler, who is well known from his explorations in Alaska, the Aleutian Islands, etc., Mr. Pinart, landed on the Ile de Pâques,

THE STONE STATUES OF THE ILE DE PAQUES.

from the ship Seignelay, and devoted several days to a close examination of these Cyclopean monuments, and ascertained, what might have been inferred, that these statues were for the most part only funereal monuments He found that they concealed tombs, and from these he gathered many crania and bones. In his account of his voyage this explorer gives many interesting details as to these statues, some of which still rest on the rock *in situ*, which is excavated out behind so that a person can walk all around, while others, as has been before remarked, are very distant from the spot where they were carved out. As a general thing, it was the craters on the isle that served as a studio for the artists—at least this seems to have been especially the case with the crater of Rana Ranaku, which Mr. Pinart describes as being oval in form, with a diameter of 1,970 feet and a depth of 650. The first statues are seen on the inner flanks of the crater, the walls of which, covered with vegetation, are slightly sloping. There are forty of them, arranged in three groups; all resemble one another, and their faces are turned toward the north. Some of them are made of trachytic rock which had issued from the volcano, while others are of volcanic breccia—a sort of amalgam of ashes and igneous rocks. But the principal manufactory is met with on the southwest summit of the volcano; and here the statues are much more numerous, some completely finished and others merely roughly sketched out and still surrounded by fragments of obsidian worked into the form of blades, scrapers, and knives, which are easily recognizable as the instruments with which the ancient sculptors worked. There are also numbers of the statues on the outer surface of the volcano, the sculptors always choosing, in making these figures, rocks situated on an inclined plane so as to be able to easily slide them down this slope after the work was once finished.

Mr. Pinart has made known to us a second class of statues on this isle, of a much coarser workmanship than the former and made from a very friable rock entirely different from that of the craters, it being composed of a congolmeration of volcanic ashes. These heads, scarcely recognizable now as such, are provided with a head-dress in the form of a cylinder of red lava, and are arranged on the terraced funereal monuments which are called by the natives *Pakaopa*.

INDIAN TRADITIONS RESPECTING THEIR ORIGIN.

By T. L. LEWIS, Bolivar, Mo.

ALMOST every tribe has its own peculiar idea of the "origin of man." Many of the South American Indians, as well as most of our Southwestern tribes, represent, in their traditions, their fathers as issuing from caves, springs, or lakes, which accounts for the peculiar veneration they have for springs, caves, and lakes.

In Peru the natives of the valley of Xanca claim to be the descendants of a man and woman who came out of the spring of Guaribalia; those of Cuzco, that they came out of Lake Titicaca; while those of the valley of Andabayla say that they came out of Lake Socdococa. There is also a Peruvian tradition that after the flood six people came out of a cave and repeopled the desolate earth.

The Caddoes, Ionies, and Ahmandankas of Texas had a tradition that they issued from the Hot Springs of Arkansas. The Mandans and Minnetaries, on the Missouri River, say they came out of a large cavern.

The Appalachian tribes claim to have originated at an artificial mound on the Big Black River in the Natchez country.

De Smet tells us of a tradition among the Blackfeet which is romantic as it is peculiar. There are two lakes, the Lake of Men and the Lake of Women. From the one man had his origin, the other woman. Upon the first meeting of the sexes the men struck up a sharp bargain with the women, in which the latter were outwitted and reduced to perpetual drudgery. The men proposed to become their protectors on the one condition that they would assume all the household care and drudgery.

The Ute Indians tell of a beginning when the earth was covered with mist, which the Great Spirit dispersed with the bow and arrow, and found the earth uninhabited. He then took clay, fashioned man, and set him to bake, but as it was only an experiment, the fires were not hot enough, so he came out white—a white man. The Great Spirit tried it again with a more intense heat. Leaving him to roast a long time, he came out black—the negro. He then fashioned one with greater skill, and after the most careful baking, he came out red—the red man, the first Indian—the most perfect type of manhood

Some others claim an animal origin, as the Toukaways of Texas, from a mole; the Lenni Lenapes or Delawares from a snail which inhabited the banks of a large river which had its source in the mountains near the rising sun. The Choctaws assert that they were originally crawfish. One day a part of the family were out enjoying the sun and were carried away and became Choctaws. The remainder are yet under the earth. Such is the general character of their traditions.—*Kansas Review.*

ON THE HABITS OF THE NORTHERN OR SHORT-FINNED SQUID (*Ommastrephes illecebrosa*).*

By A. E. VERRILL.

ON the coast of New England there are nine common species of squids, or cuttlefishes, which are often captured in large numbers by the fishermen, in fish ponds and seines, with the fishes. Many other curious kinds live in the deep water, off shore, but are rarely taken except by naturalists.

The common squid of the southern coast of New England, which is sometimes called the long-finned squid, is the best known, for it is taken in great abundance during the summer months, and is largely used for bait. This is the *Loligo pealei*. It can be distinguished by having no eyelids. It is a very interesting animal, and has many curious structures. It is well known that every squid carries within its body a curious translucent pen and a bag of ink, but when the squid is pursued by an enemy it discharges its ink and discolors the water so as to effect its escape. All squids have ten arms around the head, eight of which are shorter than the others and have powerful serrated suckers on the whole length of the inner surface, while the other two arms are much longer and have suckers only near the ends. They all swim by squirting a jet of water through a tube, called the siphon, on the under side of the neck. Their eyes are large and very brilliant, and highly organized. They have powerful jaws, shaped like the beak of a parrot, and a horny tongue, covered with sharp recurved teeth. The following account refers to the northern squid, but the modes of swimming, feeding, and changing colors are the same in both kinds.

The squid is an exceedingly active creature, darting with great velocity backward or in any other direction, by means of the reaction of the jet of water which is ejected with great force from the siphon, and which may be directed forward or backward, or to the right or left, by bending the siphon. Even when confined in a limited space, as in a fish pond, it is not an easy matter to capture them with a dip net, so quick will they dart away to the right and left. When darting rapidly the lobes of the caudal fin are closely wrapped around their body and the arms are held tight together, forming an acute bundle in front, so that the animal in this condition is sharp at both ends, and passes through the water with the least possible resistance. Its caudal fin is used as an accessory organ of locomotion when it slowly swims about, or balances itself for some time nearly in one position in the water.

When living this is a very beautiful creature, owing to the brilliancy of its eyes and the bright and quickly changing colors. It is also very quick and graceful in its movements. It is the most common squid north of Cape Cod, and extends as far south as Newport, R. I., and in deep water it has been dredged as far south as Cape Hatteras. It is very abundant in Massachusetts Bay, the Bay of Fundy, and northward to Newfoundland. It is taken on the coast of Newfoundland in immense numbers and used as bait for codfish. It occurs in vast schools when it visits the coast, but whether it seeks these shores for the purpose of spawning or in search of food is not known. I have been unable to learn anything personally in regard to its breeding habits, nor have I been able to ascertain that any one has any information in regard either to the time, manner, or place of spawning. At Eastport, Me., I have several times observed them in large numbers in midsummer. But at that time they seem to be wholly engaged in the pursuit of food, following the schools of herring, which were then in pursuit of shrimp (*Thysanopoda norvegica*) which occurs in the Bay of Fundy at times in great quantities, swimming at the surface. The stomachs of the squids taken on these occasions were distended with fragments of *Thysanopoda*, or with the flesh of the herring, or with a mixture of the two, but their reproductive organs were not in an active condition. The same is true of all the specimens that I have taken at other localities in summer. From the fact that the oviducts are small and simple, and the nidamental glands little developed, I believe that it will eventually prove that this species discharges its eggs free in the ocean, and that they will be found floating at the surface, either singly or in gelatinous masses or bands, not having any complicated capsules to inclose them. Nothing is known as to the length of time required by this species to attain its full size.

The best observations of the modes of capturing its prey are by Messrs. S. I. Smith and Oscar Harger, who observed it at Provincetown, Mass., among the wharves in large quantities, July 28, 1872, engaged in capturing and devouring the young mackerel, which were swimming about in schools, and at that time were about four or five inches long. In attacking the mackerel they would suddenly dart backward among the fish with the velocity of an arrow, and as suddenly turn obliquely to the right or left and seize a fish, which was almost instantly killed by a bite in the back of the neck with their sharp beaks. The bite was always made in the same place, cutting out a triangular piece of flesh, and was deep enough to penetrate to the spinal cord. The attacks were not always successful, and were repeated a dozen times before one of these active and wary fishes could be caught. Sometimes after making several unsuccessful attempts, one of the squids would suddenly drop to the bottom, and, resting upon the sand, would change its color to that of the sand so perfectly as to be almost invisible. In this way it would wait until the fishes came back, and when they were swimming close to or over the ambuscade, the squid, by a sudden dart, would be pretty sure to secure a fish. Ordinarily, when swimming, they were thickly spotted with red and brown, but when darting among the mackerel they appeared translucent and pale. The mackerel, however, seem to have learned that the shallow water was the safest for them, and would hug the shore as closely as possible, so that in pursuing them many of the squids became stranded and perished by hundreds, for when they once touch shore they begin to pump water from their siphons with great energy, and this usually forces them farther and farther up the beach. At such times they often discharge their ink in large quantities. The attacks on the young mackerel were observed mostly at or near high water, for at other times the mackerel were seldom seen, though the squids were seen swimming about at all hours; and these attacks were observed both in the day and evening.

It is probable, from various observations, that this and the other species of squids are partially nocturnal in their habits, or at least are more active in the night than in the day. Those that are caught in the pounds and weirs enter mostly at night, evidently while swimming along the shores in schools. They often get aground on the sand flats at Provincetown, Mass., in the night. On the islands in the Bay of Fundy, even where there are no flats, I have often found them in the morning stranded on the beaches in immense numbers, especially when there is a full moon, and it is thought by many of the fishermen that this is because, like many other nocturnal animals, they have the habit of turning toward and gazing at a bright light, and since they swim backward they get ashore on the beaches opposite the position of the moon. This habit is also taken advantage of by the fishermen, who capture them for bait for codfish. They go out in dark nights with torches in their boats, and, by advancing slowly toward a beach, drive them ashore

They are taken in large quantities in nets and pounds and by means of "jigs" thrown at random in the schools and quickly drawn through them. They are sometimes taken on lines adhering to the bait used for fishes.

Their habit of discharging an inky fluid through the siphon, when irritated or alarmed, is well known.

This squid, like the *Loligo* (or long-finned squid) is eagerly pursued by the cod, bluefish sea bass, and many other voracious fishes, even when adult. Among its enemies while young are the full-grown mackerel and herring, who thus retaliate for the massacre of their young by the squids. The specimens observed catching mackerel were mostly eight or ten inches long, and some of them were still larger.

The common long-finned squid lays its eggs in shallow water in Long Island Sound, Vineyard Sound, etc., in vast quantities, during the whole summer, and the young squids, from a quarter of an inch upward, swim in countless numbers at the surface in July and August. The eggs are done up in curious transparent packages or capsules, two or three inches long, and tapered to both ends. Several dozens or even hundreds of the capsules are often clustered together, each one being attached by one end to a seaweed, or some similar object.

* Extract from a monograph of the Cephalopoda of the Atlantic Coast, in the Transactions of the Connecticut Academy.

DESTROYING WITCH GRASS.

A CORRESPONDENT of the *Country Gentleman* gives that paper his method of destroying witch grass (*Triticum repens*) which looks to us very reasonable. Supposing the field is in grass, he plows the first furrow quite shallow, or just deep enough to invert the underground stems, from which the new plants emanate. He then lengthens his whiffletree chains and runs the plow again in the same furrow, turning up enough of the soil to completely cover and smother the buried roots and tops. With two teams the work could go on twice as fast, or as rapidly as by the usual method of plowing. The difficulty farmers experience in smothering witch grass by plowing it under, is in not covering it with sufficient thoroughness, the edges of the furrows showing live plants but partially covered, which will soon become as thrifty and vigorous as previous to the plowing. The new swivel plow, the "North American," which was exhibited at the trial of swivel plows last autumn at Pine Hedge Farm, would be an excellent implement for such work, as the shifting clevis, which can be changed instantly, would remove the necessity of lengthening the chain, which would be quite a hinderance at every turn. By such plowing, a sod field could be easily made into a good garden seed bed, suited to any crop desired, as there would be at least four or five inches of light, friable soil on the top of the buried grass.—*N. E. Farmer.*

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